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A General Outline of the Construction of Low Cost Bituminous Roads

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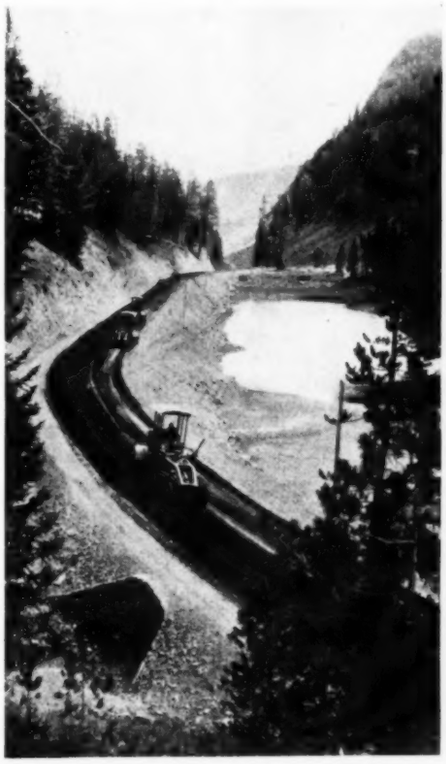
LOW cost road construction and maintenance require the greatest possible use of local materials. For this reason many types of surfacing have been developed calling for the use of a wide variety of materials and methods of construction.

Subgrade Considerations. — In designing and constructing low cost roads it is vitally important to consider the character of the subgrade soil and such other factors as moisture and climatic conditions which, to a large degree, control their behavior. The base should be so designed as to best utilize the natural value of the subgrade soil and only such additional selected materials should be introduced into the base construction as are necessary to correct deficiencies of the natural soil. For example, the non-capillary clay soils found extensively in large sections of the central states, particularly in Oklahoma, Kansas and Minnesota, retain their high supporting value when protected against surface displacement in the presence of excessive moisture. It is apparent, therefore, that the design of a base and surface for this type of soil should be such as to preserve its naturally high supporting value. The satisfactory behavior of the thin mix mats of Kansas and Minnesota and of other types of bituminous surfaces, which have been built over very thin base courses on similar soils, illustrates the adaptation of the design to utilize the favorable characteristics of the natural soil.



Road Mix Construction; Mixing With Blade Machines

In the case of the very silty soils which by themselves have low supporting value, the problem is one of increasing the natural stability. Experience has shown that this is best accomplished by admixing a local granular material to the roadbed soil rather by laying a base course. This method requires the use of less additional material and utilizes the natural qualities of the soil.

Low Cost Work on Sandy Soils.—The very sandy soils have characteristics which make them particularly adaptable to low cost road construction. They often have high natural supporting value when surfaced and in cases where they are lacking in stability, they are easily stabilized by the admixture of suitable aggregate or bituminous material. When these sandy soils are well graded and contain a moderate amount of dust, but not in excess of about 15 per cent, they are suitable for use as the aggregate in mixed-in-place bituminous surface construction. Examples of the use of this type of material in bituminous surface construction are the treated blow sand roads of Nebraska and the sandy soil roads of the coastal areas of Florida and South Carolina.

Base Should Not Develop Plastic Properties. — It is of the greatest importance to secure a base which will not develop plastic properties under changing moisture conditions. An increase in the moisture content of the base generally occurs after the surface is laid. This is sometimes of great value in increasing the stability of certain types of materials particularly the sandy soils. For certain other materials, however, which contain a high percentage of clay or other absorptive material and therefore become plastic with an increase of moisture, failure of the surface often occurs. This explains the unsatisfactory behavior of many roads as bases for bituminous surfaces even though their stability had been satisfactory when unsurfaced. To guard against failure of this type, the base when composed of granular material should not contain more than about 10 per cent of clay. A frequent cause of base failure on clay subgrades is the gradual intrusion of clay soil into the base structure resulting in ultimate loss of stability and failure. Priming the subgrade and using a choked or close graded material in the base course are means successfully used to prevent failure from this source.

Because low cost roads are generally built on flexible bases it is most important that the bituminous surface shall also be pliable in order that it may adjust itself to movements in the base without cracking or crumbling. Failure of bituminous surfaces because of excessive rigidity is a serious and common fault. Insufficient bituminous material or the use of low penetration asphalts

or liquid bituminous materials which produce hard brittle residues in the surface after curing, are factors which tend to cause excessively rigid surfaces.

Influence of Local Materials on Design.—The design of the low cost bituminous surface depends to a large degree on the type and character of local material available. This has brought about the development of numerous types of surfaces and explains why we often find wide differences in specifications for aggregates and methods of construction.

Preliminary Mixing Immediately Following Each Application of the Bituminous Material in Road Mix Construction

The preparation of specifications for low cost surface construction is very much a case of preparation for a particular project. It is generally agreed that standards either for the aggregates or for methods of construction are not as adaptable to low cost design as they are to the more expensive types. In other words, the design and method of construction in low cost road work depends largely on the conditions existing for each particular project.

Because of the large number of widely different bituminous surfaces it is difficult to classify the various types satisfactorily. The following grouping is used for the purpose of this paper:

1. *Bituminous Surface Courses*

Under this group are included all types of bituminous surfaces built to a thickness of one inch or more. The more important types included in this group are the plant and road mix surfaces using both close and open graded aggregates covering a wide range of maximum sizes.

2. *Bituminous Surface Treatments*

Under this group are included bituminous wearing surfaces of less than 1 in. thickness. Of the more important types in this group are the single and double surface treatments, blotter treatments and the thin mix mats.

3. *Bituminous Dust Treatments*
4. *Bituminous Soil Treatments*

Typical Examples of Bituminous Surface Courses.—Plant and road mix surface courses are built extensively in all parts of the country, using materials covering a wide range in type and character. Some typical examples of this work will be given.

In Florida the natural roadbed sands are road mixed with a quick curing type of bituminous material such as naphtha cut-back asphalt or cold application tar. The sand is fine grained but of a rather open type all passing the No. 10 sieve and very little, generally less than 2 per cent, passing the No. 200 sieve.

Road mixing of the sandy soils is also done extensively in South Carolina and Nebraska. The materials differ, however, from that which has been used in Florida. The South Carolina soil contains an appreciable amount of dust while the Nebraska blow sands, which are finer than the Florida sands, normally contain very little. With the road oils and medium curing cutbacks which have been used in Nebraska, it has been found advantageous to increase the dust content of the blow sand to approximately 15 per cent in order to secure satisfactory stability. Road oils and naphtha cut-back asphalts are used in the South Carolina work. In general, experience has shown that slow curing road oils and medium curing cut-backs should be used when the aggregates contain more than 5 per cent of material passing the No. 200 sieve and the quicker curing types when less than this amount is present.

In the western states the plant and road mix methods are generally applied to construction in which close graded local crushed aggregates are used. The aggregate is usually graded from ¾ in. to dust with sufficient friable soil or other suitable non-plastic material added to increase the material passing the No. 200 sieve to about 5 to 12 per cent. For this type of construction, it is important, particularly when road oils are to be used, that the aggregate shall have high inherent stability since the slow curing liquid materials tend to decrease rather than to increase the stability of the mixture.

A typical grading would be:

Passing the 1 in. round screen....	100 per cent
Passing the ¼ in. round screen....	50-70 per cent
Passing No. 10 sieve.....	35-60 per cent
Passing No. 200 sieve.....	5-12 per cent

Both road oils and medium curing cut-back asphalts are used for mixing with the close graded aggregates. Mixtures of this type are easily damaged by excessive moisture contents which cause loss of stability. It is therefore important to provide a base which will not carry excessive moisture to the surfacing mixture. It is also essential in order to avoid the necessity of early scarifying and relaying of the surface, that the mixture shall be essentially free from moisture when laid. Experience has shown that moisture in the mix in excess of 2 per cent usually results in early failures.

Materials of much higher viscosity are used in the plant or portable plant mixes than in road mix construction. Experience has shown that the materials with the higher viscosities have certain advantages among which are their superior resistance to the action of water and their tendency to produce more stable mixtures. The practice generally followed therefore is to use the highest viscosities suitable to the method of construction.

The surfaces are generally built from 1½ to 2½ in.

Mixing Completed and Partly Spread

in compacted thickness using about ¾ gal. of bituminous material to the compacted inch with some variation above or below this amount depending upon the absorptive quality of the aggregate and the amount of fines. Several formulas, most of which are based on the surface area of the aggregate, are widely used for determining the amount of bituminous material. These have, in gen-

eral, proven satisfactory in connection with the use of road oils. However, experience has shown that for materials such as cut-back asphalts, which develop a heavy residue in the road surface, somewhat higher percentages are desirable. This is true for at least two reasons: first, because the use of hardened material usually entails the loss of a considerable quantity of volatile fractions which reduces the bitumen content of the mixture and second, because with the harder residue material thicker films may be used without loss of stability. This being

Spreading Mix with Blade Machine

so, the richer mixtures may be used and advantage taken of their greater durability and resistance to water action.

Formulas for Determining Amount of Bituminous Material.—Following are some typical formulas now being used for determining the amount of bituminous material required for the close graded type of plant and road mix construction:

California..$P = .02A4 + .045B + \begin{cases} .15c \text{ for fine grained aggregate} \\ .18C \text{ for average aggregate} \\ .20C \text{ for coarse aggregate} \end{cases}$

Utah..$P = .02A + .033B + .195C + H$, where H is an absorption factor usually taken as 0.5

Wyoming..$P = 1.4\ (.015A + .03B + .17C)$

In all these formulas:

P = per cent of bituminous material

A = per cent of aggregate retained on No. 10 sieve

B = per cent of aggregate passing No. 10 and retained on No. 200

C = per cent of aggregate passing No. 200 sieve

Retread Type of Bituminous Surface.—Another important type of bituminous surface used extensively, particularly in the central and eastern states is the open graded coarse type, better known as retread. This type is adapted to both the plant and road mix methods of construction. The size and grading aggregates used vary widely depending on the material available. Generally two sizes of aggregates are used in constructing the surface. A coarse material is employed in the mix and a finer material as cover for the seal or keystone treatment which is generally applied, except when the aggregate contains an appreciable amount of material passing the ¼ in. screen. The aggregate should, in all cases, be well graded to provide stability. It is also necessary that it shall be tough and durable since in the open mixture, the individual particles are not as well protected as they are in the more closed types.

Typical gradings and sizes of aggregate used in this type are as follows:

Coarse open aggregate type—
Mix
Passing 1½ in. screen..... 95 to 100 per cent
Passing ½ in. screen..... 0 to 10 per cent
Seal or keystone treatment—
Passing ¾ in. screen..... 95 to 100 per cent
Passing ¼ in. screen..... 0 to 10 per cent
Coarse moderately open aggregate type—
Passing 1 in. screen..... 100 per cent
Passing ¼ in. screen..... 40 to 70 per cent
Passing No. 200 sieve.....Less than 5 per cent

Cold application bituminous materials of the rapid curing type such as coal tars, naphtha cut-back asphalts and asphalt emulsions are used in this construction. Materials of high viscosity are preferable in that they do not tend to run off the aggregate and also in that they provide thicker and tougher films on the aggregate particles. Applying the bituminous material in several increments when road mixing is employed is also beneficial in providing greater film thickness in this type of construction.

Bituminous Surface Treatments.—The single and

A Completed Road Mix Surface

double surface treatments have been used extensively and are probably better known than the other more local types of treatments. Graded coarse aggregates are used. The main difference between the two types is the size of aggregate and quantity of bituminous materials used. The single treatment provides a mat of from ½ in. to ¾ in. in thickness depending on the size of the cover stone while the double treatment is often built to provide a mat as much as 1 in. in thickness.

It is necessary that the bituminous binder material used in these treatments be of a type that cure quickly to give an adhesive semisolid residue. Both cold and hot application materials are used. The hot materials are considered more satisfactory for the original construction in that they give a more pliable mat which is less apt to break or crumble with movements in the base. For retreatment work, on the other hand, the cold application materials have the advantage over the hot application materials in that the cover material may be bladed or dragged to correct surface irregularities which have developed in the original surface.

Construction Procedure for Surface Treatment.—Typical procedure in the construction is as follows:

For the single treatment:

1. Remove excess dust and fines from the surface.
2. Prime the base and allow surface to dry and penetrate undisturbed for a period of about 48 hours. From ⅓ to ½ gal. of a low viscosity material such as a tar or a medium cut-back asphalt is generally used for priming.
3. Apply from ⅓ to ½ gal. of bituminous binder to the primed surface, the amount depending upon the size and amount of stone cover to be used. A satisfactory guide is to use approximately 1/10 gal. of bituminous material for each 10 lb. of stone

Two Views Taken from Approximately the Same Position Showing a Nebraska Blow Sand. Same Road Before and After Being Road Mixed with Liquid Bituminous Material

cover. It is very important that the bituminous material in this application be applied uniformly and without breaks.

4. Apply cover stone at the rate of 35 to 50 lb. per square yard. A clean, tough, open graded, aggregate preferably of a one size material should be used. Although the sizes used differ widely, 1 in. is about the maximum size suitable for this type of treatment. Careful spotting and broom dragging to secure a uniform and smooth covering are essential as this step in the construction largely determines the ultimate riding qualities of the surfaces.
5. Roll thoroughly to key and seat the cover stone.
6. A seal treatment consisting of about ¼ gal. of the binder material with a light cover of screenings is generally applied to complete the construction.

For the double surface treatment:

Preparation of the base and application of the prime are the same as for the single treatment.

The first binder application consisting of approximately 0.35 gal. per square yard is followed by a cover of 65 to 70 lb. of 1½ to ½ in. stone which is spotted, broom dragged and rolled.

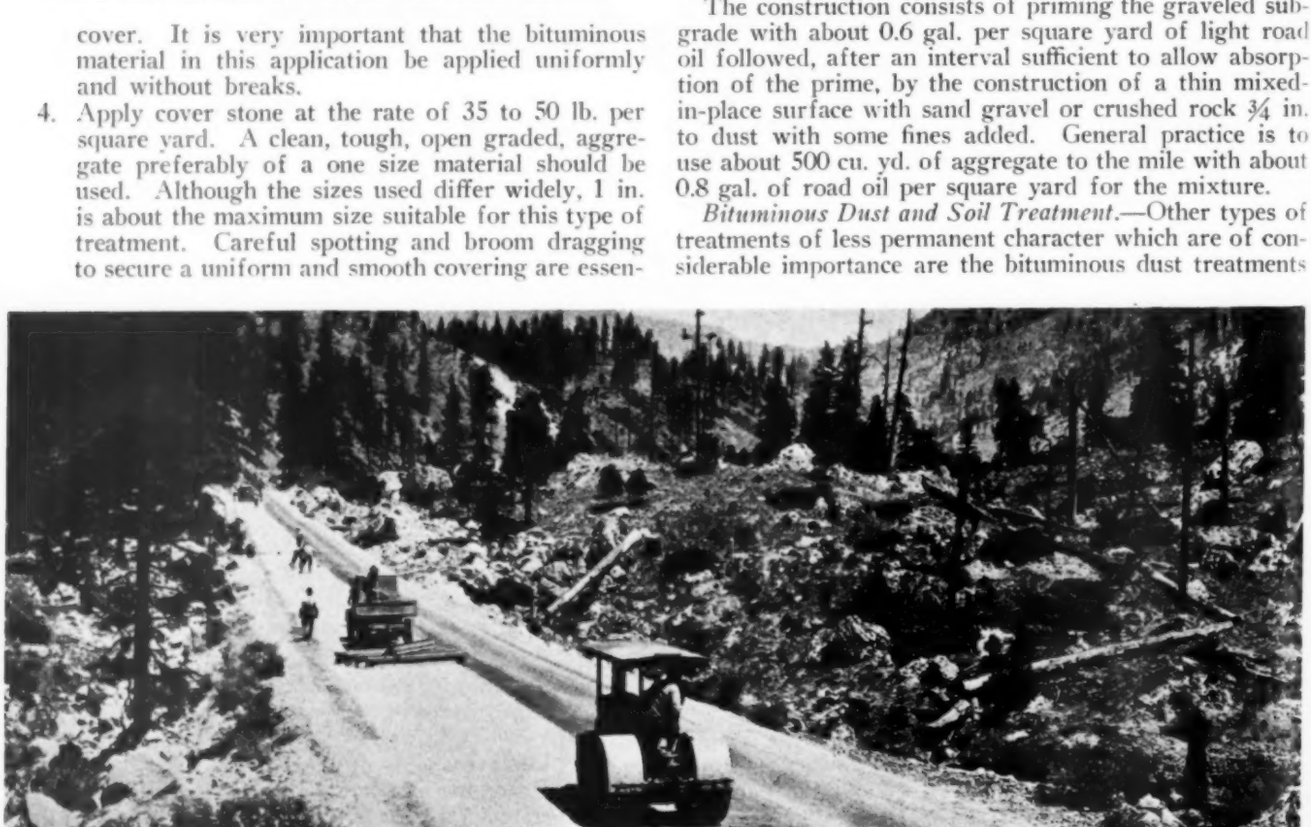
Additional binder material is then applied at the rate of about 0.45 gal. and covered with 30 to 35 lb. of ½ in. to No. 10 stone, which is also spotted, broom dragged and rolled.

This completes the construction except that additional brooming and rolling are generally required at intervals during early service.

Thin Mix Mat Type.—The thin mix mats which are built extensively in Kansas are somewhat similar, except for thickness, to the coarse close graded plant and road mix surfaces built by the western states. These mats are, however, generally constructed on soil bases which have been stabilized to some degree by the incorporation of gravel during maintenance but without any intermediate base structure. Both road oils and medium curing cut-back asphalts are used in their construction. These mats are proving fairly satisfactory on the heavy non-capillary clay soils.

The construction consists of priming the graveled subgrade with about 0.6 gal. per square yard of light road oil followed, after an interval sufficient to allow absorption of the prime, by the construction of a thin mixed-in-place surface with sand gravel or crushed rock ¾ in. to dust with some fines added. General practice is to use about 500 cu. yd. of aggregate to the mile with about 0.8 gal. of road oil per square yard for the mixture.

Bituminous Dust and Soil Treatment.—Other types of treatments of less permanent character which are of considerable importance are the bituminous dust treatments



Surface Treatment. Good Riding Qualities Are Dependent on Careful Spotting and Broom Dragging of the Cover Stone

TABLE I.—PROPOSED SPECIFICATION REQUIREMENTS FOR LIQUID ASPHALTIC ROAD MATERIALS.

Test Requirements	Material Type												
	SC-1	SC-2	SC-3	SC-4	MC-1	MC-2	MC-3	MC-4	MC-5	RC-1	RC-2	RC-3	RC-4
Water and sediment, per cent.....	2.0—	2.0—	2.0—	2.0—	....	.....	.....	.....	.....	....	.....	.....	.....
Flash point, ° F.....	150+	200+	200+	250+	....	150+	150+	150+	150+	80+	80+	80+	80+
Viscosity—													
Saybolt Furol at 77° F., sec.....	20–150	.....	.....	.....	40–150	.....	.....	.....	.....	....	.....	.....	.....
Saybolt Furol at 122° F., sec.....	.....	200–320	.....	.....	....	.....	.....	.....	.....	80–160	200–400	.....	.....
Saybolt Furol at 140° F., sec.....	.....	.....	150–300	350–550	....	150–250	300–500	500–800	.....	....	.....	275–400	700–1400
Saybolt Furol at 180° F., sec.....	.....	.....	.....	.....	....	.....	.....	.....	170–280	....	.....	.....	.....
Total distillate to 374° F., per cent by volume	.....	.....	.....	.....	....	.....	.....	.....	.....	5+	.....	.....	.....
Total distillate to 437° F., per cent by volume	.....	2—	2—	2—	10—	2—	2—	1—	1—	12+	10+	3+	0.5+
Total distillate to 600° F., per cent by volume	.....	15—	10—	8—	25+	10–20	8–20	16—	14—	25+	20+	14+	7+
Total distillate to 680° F., per cent by volume	50—	25—	20—	18—	50—	27—	25—	25—	20—	40—	35—	30—	25—
Float of residue, 122° F., sec.....	50—	25+	25+	25+	....	.....	.....	.....	.....	....	.....	.....	.....
Penetration of residue, 100 g., 5 sec., 77° F.	.....	.....	.....	.....	70–300	100–300	100–300	100–300	100–300	60–120	60–120	60–120	60–120
Ductility of residue, 77° F., cms....	.....	.....	.....	.....	60+	60+	60+	60+	60+	60+	60+	60+	60+
Solubility of residue in CS_2, per cent	99.0+	99.0+	99.0+	99.0+	99.5+	99.5+	99.5+	99.5+	99.5+	99.5+	99.5+	99.5+	99.5+
Recommended Uses													
Dust layer	X	.....	.....	.....	....	.....	.....	.....	.....	....	.....	.....	.....
Primer	.....	.....	.....	.....	X	.....	.....	.....	.....	....	.....	.....	.....
Surface treatments	.....	.....	.....	.....	....	.....	.....	.....	.....	X	.....	.....	.....
Mixed-in-place construction—													
Aggregate densely graded[1].....	.....	X	X[5]	.....	....	X	.....	.....	.....	....	.....	.....	.....
Aggregate, open graded[2].....	.....	.....	.....	.....	....	.....	.....	.....	.....	....	X	X[5]	.....
Coarse aggregate[4]	.....	.....	.....	.....	....	.....	.....	.....	.....	....	.....	X	.....
Plant-mixed construction—													
Aggregate, densely graded[1].....	.....	.....	X	X	....	.....	X	.....	.....	....	.....	.....	.....
Aggregate, open graded[2].....	.....	.....	.....	.....	....	.....	.....	.....	.....	....	X	X	.....
Aggregate, open graded[3]	.....	.....	.....	.....	....	.....	.....	X	X	....	.....	.....	.....
Coarse aggregate[4]	.....	.....	.....	.....	....	.....	.....	.....	.....	....	.....	X	X

[1]Max. size not over 1 inch. Fairly uniform grading from coarse to fine with appreciable percentage passing No. 200 sieve.
[2]Max. size not over 1½ inch. Fairly uniform grading from coarse to fine with little or no material passing No. 200 sieve.
[3]Max. size not over 1 inch. Fairly uniform grading from coarse to fine with little or no material passing No. 200 sieve.
[4]Max. size not over 1½ inch. Little or no material passing ¾-inch screen.
[5]Under favorable conditions only.

and the various types of soil treatments. Slow curing liquid asphaltic materials of low viscosity are required for the dust treatment. The treatment usually consists of a light application of the bituminous material followed by dragging or light blading. It is well to remove excess dust before applying the first treatment since excess dust will produce a rubbery type of surface which tends to rut and shove. Two or more treatments are generally required during the first year, after which they may be required less frequently. In cases where the base soil or aggregate is of satisfactory character the progressive treatment plan is often employed to develop a satisfactory and fairly permanent wearing surface.

Treatment of the natural soil roads with bituminous material has been practiced with some success in Missouri and Illinois. The method of treatment is essentially as follows:

The earth surface is shaped and consolidated and is fairly dry but free from dust when treated. Bituminous material of the slow or medium curing type and of low viscosity is applied at the rate of 0.4 to .75 gal. per square yard in from 1 to 3 applications, sufficient time being allowed between applications for the oil to be thoroughly absorbed.

Light blading is sometimes employed to aid in combining the bituminous material with the soil.

Tests and Requirements for Liquid Asphaltic Materials.—In view of the extensive use of liquid asphaltic materials in the construction of low cost surfaces, tests and specifications for the control of such materials are of particular interest and importance. In the early development of the low cost work a great multiplicity of tests were employed. This resulted in a wide variation in the requirements for similar materials and not only placed an unnecessary hardship on the producers but made intelligent comparison of otherwise similar work in various states extremely difficult.

During the past three years the state highway departments, the Asphalt Institute, the producers, and the Bureau of Public Roads have cooperated in an attempt to simplify and standardize the tests and specifications for the liquid asphaltic materials. As a result of this work the following tests were recommended for use:

1. Flash point.
2. Saybolt Furol viscosity.
3. Distillation up to 680° F. with cuts at 374, 437, 600 and 680° F.
4. Tests on the residue from distillation:
   A. Float at 122° F. or
   B. Penetration at 77° F., 100 grams, 5 seconds
   C. Ductility at 77° F.
   D. Solubility in carbon dissulphide.

Based on a study of the various state specifications and the materials submitted by the different producers to meet these specifications, test limits were suggested for 13 distinct grades and types of liquid asphaltic materials. These 13 materials were grouped according to their viscosities, distillation losses and the consistency of their distillation residues, into three classes, namely, slow, medium and rapid curing.

Table I gives the tests and test limits which were suggested for these 13 materials and the uses for which they are considered suitable.

Although not all of the states have adopted the proposed tests and specifications in whole, the tests and specifications applying to cut-back asphalts have been widely accepted and with some modifications those applying to road oils are used to a considerable extent. There is some difference of opinion as to the adequacy of the proposed tests to distinguish between suitable and unsuitable slow curing materials or road oils, particularly as to their weathering properties. Field behavior seems to show quite definitely that road oils which are produced by certain processes of manufacture and, possibly, influenced to some extent by the source of supply, have unsatisfactory weather resistant properties which make them unsuitable for certain types of construction.

An effort on the part of the consumers to eliminate such materials is largely responsible for such lack of uniformity in tests and specifications as now exists.

Several agencies including the Asphalt Institute, some of the states and the Bureau of Public Roads are carrying on research to develop some method of definitely evaluating the weathering properties of this class of materials.

Acknowledgment.—The above is a paper presented Feb. 13 at the Michigan Highway Conference at the University of Michigan.

Asphalt Highway Built in Cold Weather

A temperature of 15 degrees above zero did not stop the laying of this asphalt road surface on a public works highway in Pickaway County, Ohio. The 20-ft. bituminous concrete road 1⅓ miles long went under construction by the Ohio State Highway Department on Dec. 2 of last year. The project was approved by the U. S. Bureau of Public Roads on Oct. 6 at an estimated cost of $29,000. There are 75 men reported employed on the project.

As shown in the illustration, the asphaltic material is shoveled from a dump board in front of the finishing machine (top view); it is then smoothed by the machine and the surface tested with a template—note the steam from the surface (see middle illustration), and the surface is completed as shown in the bottom view.

The Objectives of Roadside Development

A JOINT project of the American Association of State Highway Officials and the Highway Research Board was organized in 1932 to make a survey of the laws, funds, organizations and technical practices relating to roadside development. At the last annual meeting of the Highway Research Board, Luther M. Keith, Chairman of the Joint Committee, presented a progress report defining the objectives of roadside development and discussing means for reaching them. An abstract of the report follows.

From a study of the available information, it appears that the fundamental principles of roadside development are well known to the people who have worked extensively in this field. However, the general public and many highway officials who have not heretofore been concerned with this matter have given the problem little thought. That does not mean that the citizen or tourist will not appreciate anything which is done to make the highways more pleasant and useful. The ordinary motorist may not be vocal in his desire for better looking highways, but he does not need a course in landscape architecture to be able to appreciate, consciously or subconsciously, an unmarred landscape or a pleasant shady place for a rest along the road. Nor will he have any regrets for the elimination of the many eye-sores such as billboards and signs, uninviting camps, hot-dog shacks, and ugly filling stations, automobile graveyards, and trash dumps.

Educational Work Needed.—Many of the most important phases of roadside development can not be carried out until legislative action is taken. For this reason, the people must be informed as far as possible of the need. In order to make satisfactory headway in some phases of the work, definite allotment of funds must be made for the purpose. Before any such funds are furnished, it is necessary to have the support of the taxpayers. Hence it is necessary that the public be familiarized with the aesthetic requirements and possibilities of highways. The educational work that is being carried on by highway authorities, women's clubs, Legion posts, the American Nature Association, the American Civic Association, and the National Council for Protection of Roadside Beauty and others shows that many people are willing to cooperate even to the extent of financing some betterment work when they understand what is needed.

In California, some 700 miles have been planted with trees and maintained for the first year by public-spirited individuals and organizations. The same sort of work has been done in several states and has been of great value in furnishing the general public with concrete examples of what can be done to improve the roadside appearance. Many opportunities to better the roadside appearance lie in the improvement of business structures along the way. It has been found that many owners of such establishments are willing to better the appearance of their property, but they are in need of ideas of how to accomplish it. A trade journal is now being supplied to wayside business men by the Art Center of New York for the purpose of helping them to better their businesses through improvement of their property.

Highway Engineers Should Become More Familiar with Roadside Development.—It is essential that the highway engineers themselves become more familiar with roadside development. Some states have made notable progress in this phase of highway work. Others have done very little; perhaps because of lack of public support or because the need to change prevailing practices has not been apparent. Especial impetus was given last year to roadside development by the ruling of the Public Works Board under the Industrial Recovery Act. Six items of highway work are to have priority, and the second one named is: "Appropriate landscaping of parkways or roadsides on a reasonably extensive mileage." A further ruling (October, 1933) of the Public Works Administration stipulates, by resolution, that in so far as practicable and feasible the right of way for highways built with loans or grants from public works funds after January 1 shall be at least 150 feet wide, to accommodate footpaths and screening by planting trees and shrubs.

In order to properly execute the roadside development work, the personnel of highway organizations must be educated in the practices and increasing importance of this work. The first essential is that each organization should have a competent person with authority to design and carrying out roadside development work.

Purpose of Roadside Development.—Roadside development must conserve, enhance, and effectively display the natural beauty of the landscape through which the highway passes as well as provide maximum safety, utility, economy, and recreation facilities by means of proper location, design and construction.

To conserve the landscape is to so adjust and adapt the highway as to make maximum practical use of the landscape without unnecessarily disturbing the balance of nature. This is accomplished by preservation of desirable native growth, outstanding topographical features of water courses and geological formations, scenic values, and historic sites.

Design Features.—Designs should be varied according to the kind of road (parkway, commercial, or recreational) and will be affected by the location, width of right of way, alignment and cross section. Standards will also vary with the regions they serve; some being suitable for open country and others for suburban areas. Near the larger cities, there are opportunities for parkways for passenger traffic only. Less expensive design must be used near most cities and towns, but it should be remembered that the better the highway, the farther out the urban area will spread. Most of the highway mileage will be in open country, and elaborate designs are not necessary or justified, the requirements of these roads will be met, in large measure, if adequate rights of way are provided and the abutting lands are protected from unsightly encroachments.

Location enters into the design only on those roads on new routes or radical relocations. If the road is to carry a large amount of commercial traffic, the location should minimize the depreciation of residence property. In many sections of rough country, a new location away from the old crooked roads will not involve destruction of trees and old structures toned to the landscape. Location to fit the landscape is tied up with width of right of way, alignment and cross section. The right of way must be of sufficient width for the proper cross section and also for future planting. In wooded territory, extra width will preserve strips of timber of great value and utility. Alignments both in plan and profile offer design opportunities not usually recognized except by men trained to see their effects or appearances. Curves rather than tangents fit a rolling topography. Long tangents may possibly be justified in flat country, although excessive length invites operating hazards due to boredom. The design should minimize the scars of construction. While it is desirable to have a limited number of standard cross sections, such standards should be flexible enough to fit special problems. Flat slopes rounded into the natural surface will look better and be easier main-

tained. Many times a good tree could be saved by slight changes in cross section.

Too often the highways are built where the aim seems to be to lay down a series of geometrically exact figures of cut and fill on the face of nature. A modification of this plan might fit unobtrusively into the landscape at no greater expense, even though some increased cost might well be justified. If it is worth while to spend money on embellishments of highways such as planting of trees and shrubs, it is important to plan the alignments and cross sections with due regard for their effect on appearance.

Features Preserved During Construction.—Construction practices should be revised if necessary to preserve trees or other features worth saving. In many cases, the fertile topsoil from cuts is buried in the bottoms of fills, leaving only sterile soil on the slopes, where the maintenance crew tries vainly to grow sod to prevent erosion. At no great expense, the topsoil could be saved for the slopes. In timbered country, some trees would be worthy to stand inside the cleared area without harm to the safety or use of the road.. Is it necessary to hew exactly to the inch and clear everything between two arbitrary lines? The resident engineers and contractors can find many ways to improve the new road's appearance if they are given the instructions and authority to do so. All construction debris and material should be cleaned from the right of way and its vicinity.

After construction is finished, regular maintenance will be necessary to preserve the good appearance of the roadside. The natural growth trees and shrubs will need trimming and some tree surgery will be needed for injured or diseased trees. Spraying may be needed to control insect pests. New plantings must be cultivated and perhaps watered. In some states such cultivation may be necessary for as long as five years. Weeds or other noxious growths must be cut. Trimming of trees may be required for telephone or power lines. Rubbish must be removed. Recreational facilities such as roadside parks, camps, and drinking fountains must be maintained in a neat manner.

Plantings Should Be Harmonious.—The enhancement of the landscape is achieved by properly designed plantings to enrich existing growth, to relieve monotony and add interest, to cover and screen unsightliness, and to create and frame attractive vistas.

All planting should be harmonious and adapted to the locality and should usually be native stock indigenous to the locality. Trees may be set in groups or in rows, although as a rule the group planting is preferable. In some cases, it is desirable to use non-native stock as an addition to the predominating native species. It is important that the width of the rights of way should be such that any planting will be reasonably free from future disturbance. This will require foresight as to the possible later development along the highway.

Locations usually most in need of plantings to improve appearance are grade separations, approaches to cities and towns, slopes of cuts and fills, bridge approaches, intersections, and state entrances. Pole lines and other unsightliness along the highway may be screened.

Roadside development in several of its phases adds to the safety, utility, and economy of the highway. Flat slopes from the shoulder to the ditch and on fills of less than 5 or 6 ft. permit seeding and are less dangerous to traffic than steep slopes. Flat slopes with uniform sod are easier to mow and maintain and less subject to erosion. Where it is possible to use flat slopes on fills, less guard rail will be needed. In rough country where rock is available, rock guard rail may be used for better appearance and greater safety. Backslopes of cuts should be planted to improve appearance and control slides and erosion. Erosion by streams may in many cases be controlled by tree planting. Formal plantings may be used to designate certain locations, such as schools, intersections, and railroads. Trees can be planted on the outside of curves and at sharp turns or corners to indicate change of direction. Where sufficient right of way is available, prevention of snowdrifts in the highway may be accomplished by planting hedges or trees. Parking places, even though small, where the traveler may stop, are of great utility; where feasible, these should be landscaped and equipped with drinking fountains. Where laws permit, the location and construction of pole lines should be controlled to give minimum interference with the use and appearance of the highway.

Facilities for Travelers.—Along many highways there are no places where the traveling public may stop except along the shoulder of the traveled way or upon private property. Since a large amount of travel is for purposes of recreation, there should be convenient stopping places on public property, such as picnic grounds, highway parks, drinking fountains, turn-outs and lookout points. Such areas need not be large nor expensive. On some roads, stopping places may be available in naturally wooded areas; on others, some planting will be desirable. In many places, there are small tracts between old and new locations which should be retained or acquired for the benefit of the public and to prevent their use by private business. Some small areas may even be acquired by gift from the owners. Many rights of way are wide enough to permit turn-outs or small picnic grounds to be built.

Recommendations of Committee.—Every road-building agency should contain a person competent to design and carry out roadside development work. His work should be considered an essential part of the design, construction, and maintenance.

Absolute control of the highway right of way and all its appurtenances should be vested in the highway authority.

Highway authorities should have power to acquire adequate right of way for present or future roadside development. They should also be empowered to keep or acquire title or easements in strips or parcels of land along the highway for the benefit and enjoyment of the public.

Highway authorities should budget a definite part of their funds for roadside development and its maintenance.

There should be cooperation by the highway authorities with individuals, organizations, and local communities interested in roadside development.

This committee endorses the following resolution of the Roadside Development Committee of the American Association of State Highway Officials: "The committee further recommends the establishment of state highway department nurseries only for the development of salvaged or collected native plant material, for the storage of surplus purchased material, and for the growing of such stock not obtainable from commercial nurseries."

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INVESTIGATION OF FILLERS FOR BRICK ROADS—The Engineering Experiment Station, of Ohio State University, in cooperation with the Metropolitan Paving Brick Co., Canton, O., is conducting an investigation of fillers for brick in road construction. Dr. W. C. Rueckel is investigator. While investigation of other collateral paving-brick problems is contemplated, the immediate concern of the investigation is to eliminate the exuding of filler from joints in brick roads.

Investigation of Vibratory Method of Placing Concrete Pavement

By V. L. GLOVER

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ASSUMING that sound aggregates are used, the strength of concrete and other properties relating to quality depend essentially upon the quality of the cement paste used. The quality of the cement paste in turn depends upon the degree to which it is diluted with water. The mixture must also be capable of being consolidated into a dense mass. These are fundamental principals in which any rational method of producing concrete must be in basic agreement. In addition, economy requires that the lowest cost mixture consistent with job conditions be produced.

Since the cement is the most costly ingredient of the concrete mixture, the economy of the mixture depends to a large extent upon the quality of cement paste used. Assuming that the most satisfactory proportions of fine and coarse aggregate are used, the quantity of cement paste in turn is governed by the workability of the mixture. Workability is an indefinite term implying that the mixture must be capable of being placed satisfactorily with the equipment available.

The Ideal Mixture.—Obviously, therefore, the ideal mixture from the standpoint of strength and economy, again assuming that the most satisfactory proportions of fine and coarse aggregate are used, would contain a quantity of cement paste of the required strength just sufficient to fill the voids between the particles of aggregate, a condition which can only be approached at the present time. The dgree to which this condition can be fulfilled depends upon the efficiency of the equipment for compacting and finishing.

A clearer conception of the problem may be obtained if concrete is considered as a mixture containing two components, one of which is the mortar or strength-giving medium and the other the coarse aggregate or filler. Without entering into a discussion of the question of designing concrete mixtures, it may be said that concrete of a specified strength can be obtained by designing the mortar for the required strength and consistency and adding thereto the proper amount of coarse aggregate.

The amount of coarse aggregate which can be added depends upon the efficiency of the finishing machine. Obviously, the more coarse aggregate that can be used and still fulfill job conditions as to strength and workability, the more economical will be the concrete. Also, if it is possible because of the type of equipment to reduce the water content of the cement paste, further economies may be effected.

Illinois' experience with concrete mixtures clearly indicates a definite limit in the amount of coarse aggregate that can be used with a given quantity of mortar and still obtain satisfactory compaction and surface finish with the type of equipment now available. In this respect Illinois' experience is no different from that of others. Every agency, therefore, engaged in concrete construction should be interested in developments in equipment which will provide for better compaction.

New Type Finishing Machine Utilizes Vibration.—During 1932 the Illinois Division of Highways was offered for experimental purposes a new type of finishing machine utilizing vibration to compact and finish concrete in pavements.

This machine was of the standard type, except that the screeds were heavier and wide and equipped with electrically driven vibrators operating at about 3,600 impulses per minute. Four vibrators were mounted on the front screed and two on the rear. In addition the front screed was designed to aid in bringing the concrete into the most favorable position for vibration. The screeds were operated in the usual manner, vibration being imparted while the screed was in motion.

Figure 1 is a view of the finishing machine showing clearly the four vibrators mounted on the front screed. The electric generator is also visible.

Experimental Test Section.—An experimental test section of approximately one mile of pavement, consisting of 114 individual sections, was constructed. Gravel was used for the coarse aggregate in about half of the sections and crushed stone in the remainder. With a few exceptions, the individual sections were placed with different mixtures.

Fig. 1—The Finishing Machine

The mixtures were designed to determine the limiting quantities of coarse aggregate which could be used with mortars of varying consistencies and to determine the mixtures best suited for the equipment. The possibility of reducing the amount of mixing water was also studied. The mixtures regularly used with the standard finishing machine were utilized as a basis for comparison.

The general scheme was to vary the constituents of the mixtures as much as possible and in such manner that the effect of variation in quantities of water, fine aggregate, and coarse aggregate per bag of cement could be studied separately. With exception of those in which the amount of mixing water was the variable, all mixtures were designed for a given strength.

In cement content, the mixtures ranged from 1.10 to 1.60 bbl. per cubic yard. The ratio of fine aggregate to the total quantity of aggregates varied from 30 to 40 per cent. The slump varied from 0 to 3 in.

It was evident from the start that mixtures too rich in mortar were definitely unsuitable because too much mortar was worked to the surface and wasted over the forms. Mixtures having a ratio of fine aggregate to total quantity of aggregate from 32 to 35 per cent, depending somewhat on whether the coarse aggregate was gravel or crushed stone, appeared to contain about the correct

amount of mortar. The most suitable consistency was about ½ in. slump or slightly greater.

Mixtures containing large amounts of coarse aggregates required more than the specified amount of mixing water, and the quantities of aggregate which could be used were limited by this condition. Probably the most suitable mixtures contained 1.25 to 1.30 bbl. of cement per cubic yard of concrete, depending somewhat on the type of coarse aggregate. This represents a saving in cement of about 15 per cent or nearly one bag per cubic yard of concrete. Reduction in cement content substantially below this resulted in general in the use of additional mixing water and reduced strength.

Determination of Quality of Mortar.—The aggregates were tested and the batch weights corrected in accordance with standard practice. Slump tests were made to aid in the study of consistency. The operation of placing, compacting, and finishing was studied closely and detailed records kept. Four 6 in. x 12 in. cylinders and two 6 in. x 6 in. x 30 in. beams were made from each experimental section. Six 2 in. x 4 in. mortar cylinders were made from several sections to determine the quality of the mortar as deposited and after having been worked to the surface.

The 6 in. x 12 in. cylinders were molded in paraffined cardboard containers, filled and vibrated on the front screed from 20 to 30 seconds. The 6 in. x 6 in. x 30 in. beams were molded in steel forms, filled and vibrated for the same length of time with special apparatus applied to the surface of the concrete and to the form. The 2 in. x 4 in. cylinders were cast in brass molds using mortar screened through a No. 4 sieve, half of each set being obtained from the concrete as deposited on the subgrade and the other from the surface after the second trip of the machine. The beams and large cylinders were cured in damp sand and the small cylinders in water. The beams and cylinders were tested at the age of 14 days.

When the concrete had hardened sufficiently, five cores were drilled from each section, at points where the batches overlapped when deposited on the subgrade, and three at representative points within the section. The cores were tested at an average age of 74 days.

Tests of the specimens did not, in general, show that the strength was reduced by the use of increased quantities of aggregates as long as the mixing water was not increased beyond that specified. Neither did the tests of the mortar cylinders show that inferior surface mortar resulted from the use of this machine.

What the Cores Showed.—The cores showed that the concrete from even the harshest mixtures was consoliated satisfactorily. In fact, the honeycomb found was no more pronounced and no more frequent than that found in cores from pavement constructed with standard equipment. The pavement edges where some of the harsher mixtures were used showed some honeycomb because of difficulties in spading along the forms. The surface finish, however, was satisfactory. A few high or low spots occurred in some of the sections, which might have been expected considering some of the mixtures used.

As previously mentioned, some studies were made of the possibility of reducing the mixing water to obtain stronger concrete. These studies were not very comprehensive and definite conclusions cannot be made. It was indicated, however, that a reduction of nearly one gallon of water per bag of cement from the amount used with standard equipment might be possible, assuming that the most satisfactory proportions of fine to coarse aggregates were used.

One of the objects of this investigation was to study the dgree to which the cement content could be reduced without a reduction in strength, and another to determine the most suitable proportions of fine to coarse aggregate.

Proportions of Aggregate.—The quantities of aggregates per bag of cement for all mixtures, except those used in the study of the reduction of mixing water, are shown in Fig. 2. Quantities of fine aggregate are plotted as abscissas and quantities of coarse aggregate as ordinates. The upper quadrangle represents the gravel mixtures and the lower quadrangle the stone mixtures. Each of the vertical lines represent the mixtures containing a constant quantity of fine aggregate but varying amounts of coarse aggregate. The sloping lines each represent the mixtures in which the fine aggregate is the major variable, and in which the coarse aggregate is varied only to keep a constant relation between the volumes of mortar and coarse aggregate. The mixture designated as Group A, FA-Series on each chart represents the proportions used with the standard equipment.

The contour lines indicate mixtures which appeared to be satisfactory. Below these areas the mixtures in general contained too much mortar; above the areas, too much coarse aggregate; to the right, too much mixing water to produce the design strength; and to the left higher strength concrete than is required.

Economic considerations justify the selection of mixtures toward the upper right hand corners of the indicated areas as the most suitable for the equipment; and the Group E, CA-12 mixtures on each chart were selected as being suitable and well within the workable range. The difference in cement content between the Group A, FA-Series and the Group E, CA-12 mixtures on each chart represents a saving in cement of nearly one bag per cubic yard of concrete or about 15 per cent.

The left hand and lower limits of the areas enclosed by the contour lines need no further explanation and need not be located with great accuracy since these mixtures are unsuitable, if for no other reason than the fact that they are uneconomical.

The field notes on workability indicate that the CA-16 mixture contained about the maximum amounts of coarse aggregate from a practical standpoint. Increasing the mixing water in these mixtures did not, in general, increase the workability to any degree, but did cause segregation of the coarse aggregate from the mortar. At least it was determined that the strength of any of the mixtures in Groups E and G was satisfactory and the upper limit was determined by observation of the workability of the mixtures.

Mixtures containing more aggregate than those in Group G, in general, required more than the specified amount of mixing water and lower strengths resulted. Excess mixing water increased and strength decreased with each increment of increase in coarse aggregate.

It is apparent, therefore, that the limiting amount of aggregate is somewhere between the Group G and Group K mixtures. The data for the Group I mixtures do not indicate clearly the right hand limit of the areas enclosed by the contour lines, probably because only one Group I gravel mixture was used. This limit, however, is indicated quite definitely from the data showing the amount of fine aggregate as the variable. The sloping lines representing the CA-8 and CA-12 mixtures, which pass through the upper right hand corner of the areas enclosed by the contour lines, show that the limiting amount of fine aggregate is 235 lb. per bag of cement, or slightly greater.

Apparently the upper and right hand limits of the areas are established fairly definitely as being in the vicinity of the CA-16 and Group G mixtures, respectively. The CA-16 gravel mixture contained about 1.15 cu. ft. of

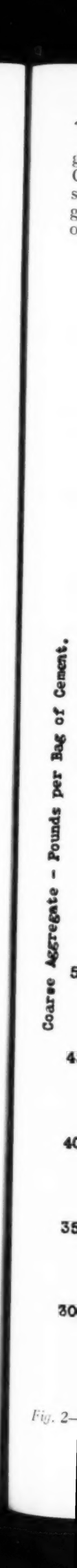

Fig. 2—

gravel, absolute volume, per cubic foot of mortar. The CA-16 stone mixtures contained about 1.02 cu. ft of stone, absolute volume, per cubic foot of mortar. Both gravel and stone mixtures in Group G contained 235 lb. of sand per bag of cement.

If materials of different characteristics had been used it should be made clear that the results might have been different. However, while the maximum quantities of aggregate may not be the same for all materials, the fact that approximately the same saving in cement was ac-

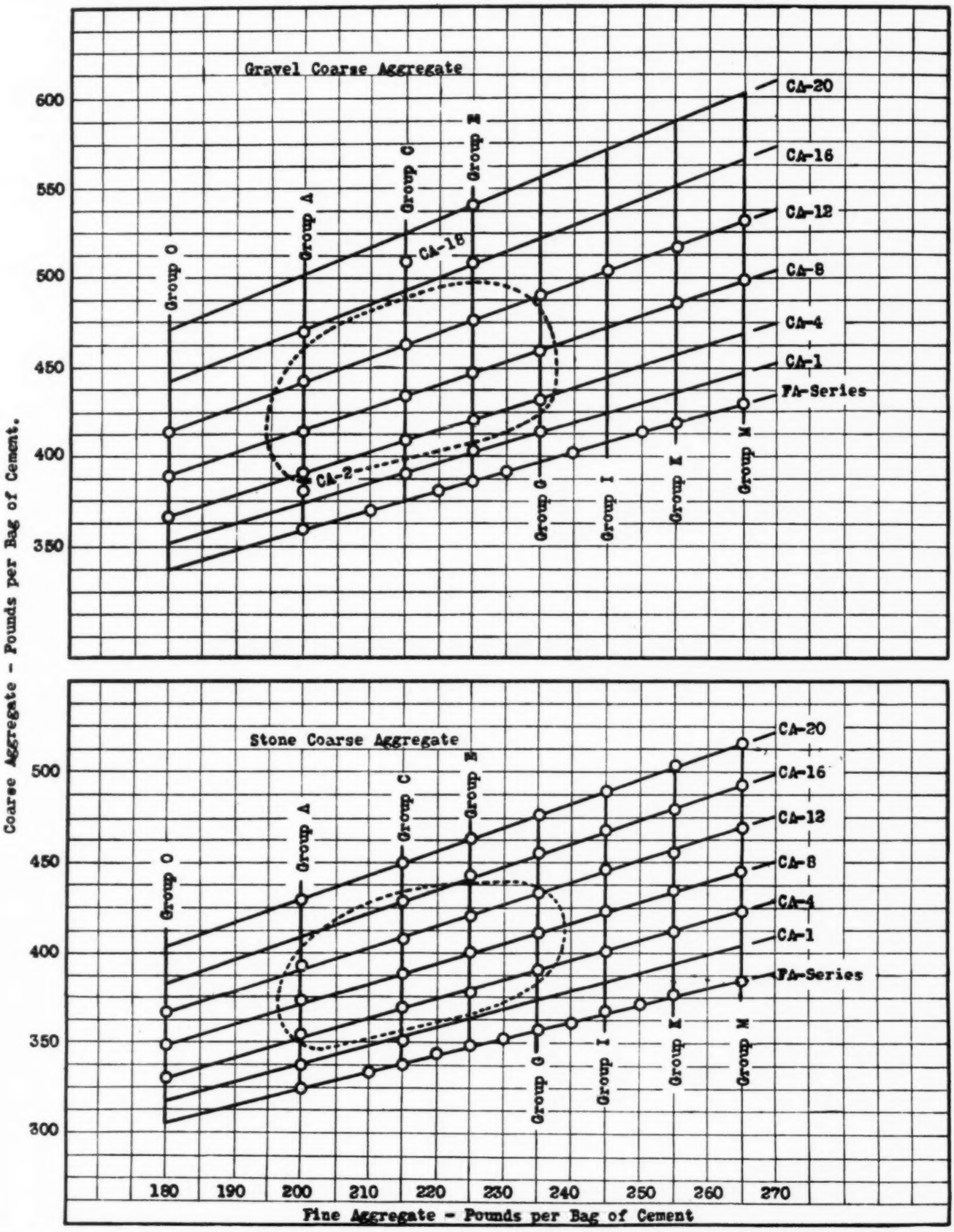

Fig. 2—Diagrams Showing the Proportions of the F. A. and C. A. Mixtures. (The Areas Enclosed by the Contour Lines Represent the Mixtures Most Suitable for the Equipment under the Present Requirements for Strength.)

complished with both gravel and stone in this particular case indicates that approximately the same saving would result had materials of different characteristics been used.

Shortly after opening the test section to traffic, the surface of some of the sections exhibited signs of scaling, whereas the adjacent pavement built with the standard finishing machine showed no evidence of this defect. Many of the mixtures which were most suited to the vibratory equipment, however, did not exhibit this tendency to any great degree, and it is possible that the excessive working of the harsher mixtures during the placing and finishing caused or contributed to the occurrence of the scaling. It is logical to assume that if all mixtures had been suitable for the equipment, little or no scaling would have occurred. As substantiation of this assumption, reports indicate that no scaling occurred on test pavements built with this machine in Texas and Missouri. Furthermore, this scaling is not progressing after a period of 1½ years and it cannot be termed serious.

Results of Investigation Summarized.—Summarizing the results of this investigation, it may be said that satisfactory pavement was obtained for most if not all of the mixtures placed. The efficiency of the finishing machine in handling and consolidating the mixture into a dense mass was remarkable. Even the harshest mixtures were placed satisfactorily and honeycombed concrete was no more pronounced and no more frequent in any of the experimental sections than in pavements constructed with the regular equipment. Spading of the edges was difficult; in fact, in some of the sections spading by ordinary methods was impossible.

The mixtures most suitable for the equipment had a slump of about ½ in., a ratio of fine aggregate to total aggregate of 32 per cent for gravel mixtures and 35 per cent for crushed stone mixtures, and a cement content of 1.25 to 1.30 bbl. of cement per cubic yard of concrete, or about 15 per cent less than contained in the standard mixture. This is equivalent to a reduction of about one bag of cement per cubic yard of concrete.

No particular reduction in the design strength of the concrete was noted except where excess water was necessary to place the harsher mixtures. Tests of mortar cylinders did not indicate that the strength of the surface mortar was reduced from overworking. It appears that the water content of the standard mixture could be reduced about ½ gallon per bag of cement which should result in a substantial increase in the strength of the concrete without increasing the cost appreciably.

If this type of equipment can be perfected, two courses are open whereby advantage may be taken of the increased efficiency of the machine. If it is desired to build pavements of the present cement content, the water content of the mixtures and the ratio of sand to the total quantity of aggregates may be reduced considerably and higher strength concrete be produced without increasing the cost of the materials to any extent. If it is desired to maintain the standard strength mixture, then there is a possibility of reducing the cement content approximately one bag per cubic yard of concrete, which would result in a saving in cost.

It should be remembered that one of the objects of this investigation was to test the finishing machine to the limit of its capacity to consolidate dry, rocky mixtures, and it may be safely said that this object was accomplished. As might have been expected, the results as far as the production of pavement is concerned were not entirely satisfactory in the case of some of the mixtures, but from the investigation, the workable range of proportions for satisfactory concrete was rather definitely determined, which should establish these proportions for use in future investigations or for the actual use of the machine. Figure 2 provides a means whereby proportions for future work may be selected and insure that the concrete will be within the range of workability.

Acknowledgment.—The foregoing is a paper presented at the 20th annual Michigan Highway Conference, held at University of Michigan, February 13, 14 and 15.

General Contractors to Be Registered

With its membership officially approved by NRA, the General Contractors' Division Code Authority, set up under chapter two of the Code of Fair Competition for the Construction Industry, met at Washington last month to perfect arrangements for registering every general contractor in the country and launching active administration of the code which became effective March 19.

The meeting was called under the temporary chairmanship of A. E. Horst, Philadelphia public works contractor and past president of the Associated General Contractors of America, which organization has been named in the code as the sponsoring trade association for administrative purposes.

Permanent officers of the Authority were announced as follows: A. E. Horst, chairman; A. C. Tozzer, of Turner Construction Co., New York, vice-chairman; E. Marshall Rust, of the Rust Engineering Co., Pittsburgh, treasurer; E. J. Harding, managing director of the Associated General Contractors of America, secretary; and Louis W. Hickey, of Dallas, Texas, executive manager.

In addition to the officers, those appointed to the Authority are:

Heavy construction and railroad contractors: E. T. Foley, of Foley Brothers, Passadena, Calif.; Nick F Helmers, of Siems-Helmers, Inc., St. Paul, president of the Associated General Contractors; E. P. Palmer, of Senior & Palmer, New York; and James B. Bray, of W. W. Boxley & Co., Roanoke, Va.

Building contractors: W. F. Austin, of W. E. Wood Co,. Detroit, Mich.; F. L. Shackelford, of Potter & Shackelford, Inc., Greenville, S. C.; W. A. Klinger, of William A. Klinger, Inc., Sioux City, Iowa; Robert A. Whidden, of Whidden Co., Boston; and William C. Miller, of W. C. and A. N. Miller, Washington, D. C.

Highway contractors: Robert E. O'Connor, of J. C. O'Connor & Sons, Inc., Fort Wayne, Ind.; H. B. Zachry, of H. B. Zachry Co., Laredo, Texas; L. E. Ray, of the Diamond Engineering Co., Grand Island, Nebr.; Eugene B. Forrestel, of the Cold Spring Construction Co., Akron, N. Y.; and Charles H. Simpson, of the Municipal Paving & Construction Co., Nashville, Tenn.

One of the first actions taken by the Authority was to order the registration with the Divisional Code Authority through such agents as it shall designate of all construction projects exceeding $2,000 in value undertaken on and after March 19. The question of designating local and regional agencies to assist the Authority in administrative functions also was considered.

Messrs. Holmers, Horst, Tozzer and O'Connor are likewise members of the Code Authority for the Construction Industry, which met in Washington on March 23 for the purpose of making nominations to the National Construction Planning & Adjustment Board which is to be set up under the code to promote better relations between construction employers and employes. The Board is to be composed of ten representatives of the employers, ten representatives of employes and an impartial chairman to be appointed by the President.

Headquarters for the General Contractors' Divisional Code Authority have been established at the Munsey Building, Washington, D. C.

Handling Traffic at Intersections

By MAXWELL HALSEY

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THE intersection represents the greatest problem in traffic control for the following reasons:

Intersections are the meeting point of highways and frequently form the nucleus around which communities are formed.

The paths of vehicles cross at intersections most frequently and more opportunities for accidents exist.

The building of houses, stores or the presence of hedges and signs greatly reduce the visibility necessary for safe operation.

The intersection is the point at which most pedestrian crossings take place.

Intersection property is the most valuable and frequently has improvements built upon it. The increased cost of alteration prevents many desirable changes.

There are so many different methods and types of controlling traffic that this presentation will take them up in chronological order—as the intersection starts out and develops.

Rural Highway Intersections.—The rural intersection usually requires different treatment than the urban location—speeds are higher, the volume of traffic less and pedestrians are not usually a problem.

When the intersection is first built and has little traffic upon it, there is usually no problem. The visibility is good and congestion and accidents do not prevail. It will usually operate best with no artificial control.

As the traffic increases slightly, it may be advisable to erect an "Information" sign which serves to tell motorists where the cross street goes to and advise them of its presence.

As the traffic increases still more, it becomes advisable to erect a "Caution" sign advising motorists that he is coming to an intersection and that a vehicle may come out of the cross street. This is sometimes advisable even though the visibility is good. Motorists frequently see an intersection but believe it so little used that they fail to exercise caution in approaching it.

As the intersection develops, buildings begin to appear and visibility is reduced below that safe for speeds which motorists have been in the habit of using in approaching it. Speeds through intersections may have been (or still are) 35 miles per hour, whereas visibility has been reduced to such a point that if you approach over 20 miles per hour, when you are first able to see a car coming from the cross street, you are too close to the intersection to stop. If speeds of 15 or 20 miles are safe, there is no necessity for installing a stop sign which has a higher inconvenience factor. The safe approach speed is the coming method of relating visibility and speed at intersections. It will prove a popular sign because it is specific and is based on facts.

When it is Advisable to Install Stop Signs and Traffic Signals.—In some cases one of the streets gradually becomes an artery. The traffic becomes quite heavy and consistent. It is eight to ten times that of the other street and the average speed has gone up. The street actually goes somewhere and fairly "long-run" motorists are using it. At approximately this point, it becomes advisable to install stop signs. If the traffic is heavy, such signs serve a useful purpose in preventing the cross traffic from dashing into the heavier flow, even though the visibility is good. As the speed on the artery increases the visibility may not be adequate. The stop sign brings the cross street vehicle right up to the main street where it can be seen for some distance on the artery. This increases the visibility on the artery and permits a higher safe speed.

As the total volume increases to between 500 to 1,000 vehicles per hour another method of control comes into the picture—a traffic signal.

Let us assume that signs have been illuminated and flashing beacons installed and that the problem has grown more severe—accidents are happening because of disobedience and the inability of the vehicles on the cross street to get across the main flow.

The installation of a fixed time signal at a light traffic unbalanced point would be difficult, with the possible exception of very short cycles, 35 to 90 seconds. You desire a short total cycle because of the light volume. The highly unbalanced flow of say 90 per cent on the main street and 10 per cent on the cross street cannot be worked out on a 40 or 50 second cycle—actuated signals appear to fit such a situation particularly well.

As the volume increases still more until the flow is balanced or the total is much higher, the use of the fixed time signals become effective. With a longer cycle an unbalanced proportion is possible or with a balanced flow, a short cycle can be used.

Now Necessary for Remedial Measures for Intersection.—As the volume goes up still more, the total capacity on both streets begins to exceed the capacity of the intersection. The intersection can only carry about 40 per cent of the traffic brought to it by the two streets. Fifty per cent is lost because only one street can move at a time. About 10 per cent is lost in starting and stopping traffic. At this point strenuous efforts should be made to increase the efficiency of the intersections as much as possible without reconstruction. The following are suggested methods:

1. The use of lanes-lines to get traffic (vehicles and pedestrians) lined up and through the intersection in as orderly a manner as possible.
2. The use of turning markers to facilitate left turns.
3. A more accurate timing of traffic signals as follows:
   a. Time clock to change cycle and proportion to traffic at the peak and off-peak hours.
   b. Provisions of special interval for left or right turns, using arrows.
   c. Use of a full actuated traffic signal.
4. A restriction of parking (if any) back 100 feet from the intersection.
5. Increasing the signal faces so that their changes can be seen more easily.

As the flow increases still more, it becomes necessary to alter the physical shape of the intersection if congestion is to be reduced. The two following methods which may not require a "major operation" are suggested:

1. The widening of the roadway back from the intersection a distance of about 10 feet. This provides an additional "entering lane" and for every 10 seconds of green permits a larger number of vehicles to pass through the intersection.
2. The providing or cutting through of a special lane for "right turning vehicles." In the absence of pedestrians this can be almost a continuous movement.

Major Operation Now Necessary.—But the traffic flow continues to increase until even all these remedial measures cannot reduce serious congestion. When this happens the time has arrived when a major operation is necessary to change the design of the intersection so that there are no direct crossings and something off-working a continuous flow is possible. The rotary traffic or

round-about. Such a design will carry large volumes, the amount being controlled by such factors as (1) diameter of the circle, (2) width of roadway, (3) angle of approaching streets.

As traffic increases still more, however, there comes a time when the rotary system breaks down and a grade separation is necessary, for one of the following reasons:

1. The diameter of the rotary must be increased (to carry the flow) so much that in many instances the cost of property and construction will equal or exceed that of a full grade separation.
2. With high speed heavy traffic, the delay of comparatively slow speeds—20 or 25—necessary for weaving provides a considerable time delay.

A balance between the rotary traffic system and the grade separation must be obtained. This will be affected by the physical conditions at the intersection. The result might be a combination of both.

Urban Intersections—The urban intersection usually offers a considerably different problem than that found out on the highway for the following reasons:

1. Heavier traffic volume.
2. Pedestrian volume.
3. More buildings and structures.

With the "new intersection" progress of control will go through the same first four stages of the highway. The first change is brought about by presence of the pedestrian.

One answer which has been growing in use has been the pedestrian push button. The standard traffic signal is sometimes flashing yellow in the absence of pedestrians but goes red for a pre-determined period when the push button is used. One state has used a flashing green on the main street and flashing red on the side street. This is the least expensive method but it has the following disadvantages:

1. The yellow signal is not material or does not slow traffic down—possibly because of a general lack of enforcement on this color.
2. The vehicular cross traffic problem is not entirely solved.
3. Operators are not accustomed to having a flashing indication change to a red or green.

A more satisfactory answer but one costing more, is the installation of a semi-actuated traffic signal system with treadles or actuators for vehicles and push buttons for pedestrians. This signal normally stays green on the main street and red on the cross street until actuated by vehicles or pedestrians when a sufficient time to cross is provided.

If the vehicular volume is sufficiently heavy or evenly balanced to use a fixed cycle signal efficiently, a push button may be tied into it so as to stop all traffic. It may be charged that if there is much vehicular traffic a stopping of all traffic will be serious. However, at certain locations near schools, churches, factories during certain hours of the day, the number of pedestrians may warrant this.

In other cases the push button may merely be used to lengthen the amount of time given to the cross street.

The use of the push button may be restricted so that it is only effective once a cycle or once every other cycle.

The trouble has been in the past that artificial control has been applied without regard for the facts at the intersection or the normal progression—mechanisms which have had a higher degree of irritation and inconvenience than was warranted to reduce the accidents.

Choice of Traffic Signals.—It is obvious that the more flexible the signal the more it will cost. The choice should be based on two things (1) the traffic characteristics and (2) the money saved by reducing accidents and congestion. The normal progression will be (a) fixed time signal (b) fixed time signal with time clock for automotive cycle and period changes (c) semi-actuated and (d) full actuated. At almost any intersection of even medium volume, it may be stated that the more flexible the equipment the less delay and the higher obedience and hence probably the fewer the accidents. From the political and public pressure viewpoint it is sometimes better for the traffic authority to put in a more flexible piece of equipment than conditions warrant (if the money is provided) than to refuse an installation. If the equipment is flexible enough to fit the condition it can do no harm and will assist in reducing accidents even under extremely light traffic conditions.

Many Problems Involved.—In addition to the type of signals to be used and under what conditions, there are many other problems involved.

One of the most difficult problems is that of the clearance period now used almost everywhere—the yellow following the green. This is usually set to clear vehicles traveling at over 15 miles per hour. The result is that the pedestrian traveling at two and one-half to three miles per hour finds himself stuck in the street, even if he has started on the green (latter part). If the yellow is lengthened to fit the pedestrian, it is too long for the vehicle.

Pittsburgh and Philadelphia have attempted to solve this by having two separate clearance periods. The yellow comes on with the green for the pedestrians. This tells the pedestrian that if he starts from the curb, he will not be able to get across the street before cross traffic is started. Vehicles continue to move on this period but know that a change period is coming. The green then goes off leaving the yellow which is the clearance period for the vehicle. The system has possibilities but because of its complexity, has serious difficulties.

Several cities are now experimenting with a separate light for pedestrians to tell them when so little of the vehicle green remains that they should not start from the curb.

It would appear that the change period must be altered and that there is a strong possibility of separate pedestrian periods coming into use.

Whenever pedestrians are a problem, it is recommended that additional faces be installed (usually set at right angles to the far right corner signal) so that each of the eight pedestrian movements has a signal facing it.

Experience has shown that the shorter the cycle, the easier it is to get pedestrians to obey the signals. In most parts of the country it is believed that the time has not yet come when pedestrian control can be handled by rigid laws. Moral suasion and smiling police officers can accomplish the most today.

Most engineers will agree that the best plan is to not require the pedestrian to cross more than two moving lanes at one time. This means that on any street wide enough for four moving lanes, a pedestrian island should be installed. If street cars are present they may be combined with loading zones.

It is believed that marked cross walks are essential. Everything possible should be done to have the pedestrians cross the street at one place—the cross walk. This reduces the area of confusion and the motorist knows where to expect the pedestrian. Chains on loading islands and fences on the curb are other methods being used for accomplishing this.

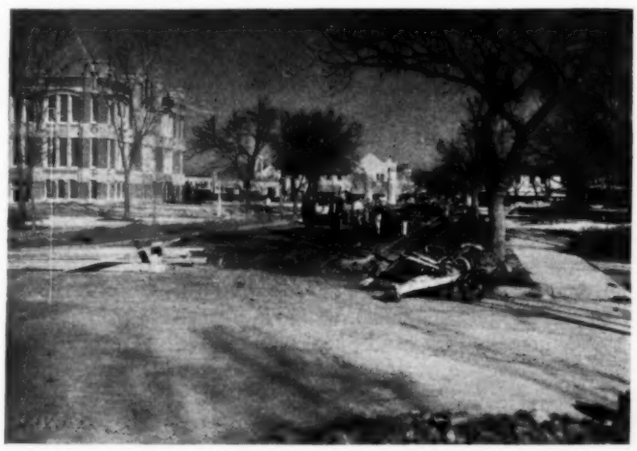
Acknowledgement.—The foregoing is a paper presented Feb. 15 at the Annual Conference on Highway Engineering at the University of Michigan.

Heated Canvas Shelters
Protect Winter Concrete Paving Job

By MAHLON D. HICKMAN

SHELTERS made of wooden frames covered with waterproof material and heated by gas were used last winter on a concrete paving job at the University of Oklahoma, Norman, Okla. The work was done under a CWA grant which required that the project be completed by Feb. 15.

A shelter unit consisted of a wooden frame, 18 ft.



Grading and Preparation of the Street. A Gravel and Oil Roadway Had to Be Removed to Make Way for the New Surface

square with legs 24 in. high, which was covered with canvas. The frame was made of two-by-sixes, with braces cut from one-by-eights. A hole was left in one side for a burner.

The burner was made from a piece of old 8-in. pipe. Into one end of this was put the fuel line, a 1½ in. gas pipe. The gas, which was used at a pressure of 30 lb., made a draught of air from the open end of the larger pipe, thus creating a bunsen burner. A sheet of corrugated iron was suspended above the burner. The end nearer the burner was arched, to retain the heat, while the farther end was flattened out, to spread out the heat.

Finishers at Work. The Engineering Building, Home of the College of Engineering, for which the University of Oklahoma Is Noted, Is Shown in the Background

The entire heater was made by the utilities department of the university at a very low cost.

Twenty shelters were built under the direction of B. F. Shultz, Chief Engineer. Five of them were covered with waterproof material, and the others were covered with 8-ounce ducking. The plan was to use the waterproof covers over the last part of the day's run. It was decided that the lighter covering would be sufficient protection against rain on the concrete that had been setting for two or three hours.

When the shelters were completed, the pouring began. The men work in two 5-hour shifts, from 7:30 to 12:30 and from 12:30 until 5:30. At about 4:30 every afternoon, a squad of men was put to work placing the shelter

The Shelters in Place and Connected, Ready for the Night. The Left Side of the Strip Is a Day Old, and Is Covered with Dirt

units. Heavy burlap was hung around the sides, and the lower part of it covered with dirt.

The finished job was a long, low shelter, fairly tight and semi-waterproof. The gas pipe was run along the front of the shelter, with a connection every 18 ft. A flexible hose completed the connection. The burner was regulated to keep a temperature of from 50 to 75°.

The covers were given a daily inspection, to see that they had not been damaged. They were checked again at about 10 o'clock at night to see that the proper temperature was being kept. A night watchman watched the shelters for a possible fire, and regulated the heaters according to the changing weather.

All concrete which was used in the paving project was heated in the mixer by a gas burner similar to those used in the shelters. The burner was put on the windward side, so that the flame was blown into the mixer. The mixture was heated to a temperature of from 70 to 85°.

The daily concrete runs averaged from 250 to 300 lin. ft. On one part of the project, less than 200 lin. ft. of concrete was being run each day. It was found that good use could be made of the extra shelters by using them to heat the ground for the next day's run.

By doing this, it was possible to begin pouring at 7:30 in the morning, instead of having to wait until the mercury started its daily climb. Under these conditions it

A Closeup of One of the Heaters

was possible at times to run concrete while the temperature was below freezing, instead of having to wait for 35 degrees or more.

On days when the shelters were all in use, and there was frost in the ground, a gas torch, carried by a man, was used to heat the ground before the concrete was run. Even on the warmer days, the ground was covered with tarpaulins to keep it warm over night.

It is estimated that the shelters cost about $30 each. The burners were made from old material, at a nominal cost. Cost of gas was about $45 for the eight weeks that the work required. Salvage value of the shelters, it is figured, will be about 50 per cent of their original cost.

Thus a cost of approximately $350, plus the cost of labor required to cover and uncover the slabs daily, provided insurance on the new paving. It is estimated that the labor cost was about the same as the net cost of the shelters. The cost of the "insurance," then, was about 6.25 ct. per square yard, or less than 3 per cent of the cost of the paving.

Another interesting result was the fact that the hydrogen in the gas, combining with oxygen in the air, made sufficient moisture inside the shelters to keep the air damp at all times. A very good seasoning of the concrete was the result.

A total of 11,270 yd. of concrete was laid in eight weeks.

The work was done under the direction of Walter W. Kraft, Superintendent of Utilities at the University of Oklahoma. He devised the shelter plan for protecting the concrete.

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Slag as an Aggregate for Concrete

Experiences of the Ohio State Highway Department in the use of slag as aggregate for concrete were outlined by R. R. Litehiser, Chief Engineer, Bureau of Tests, of the department in a paper presented at the 1924 Conference on Highway Engineering at the University of Michigan. The matter following is quoted from his paper:

Our specifications require that the slag shall be composed of air-cooled blast furnace slag and shall be clean, sound, durable, reasonably uniform in density, and free from thin, elongated or glassy pieces. Slag is required to meet the same quality requirements as determined by our modified abrasion test and soundness test, as crushed limestone. In this respect there is an equation with gravel also, taking into consideration the amount of roundness and angularity, so that we virtually have a specification of coarse aggregate for concrete which may be met by gravel, limestone or slag of the same physical characteristics. In addition, slag is required to meet a minimum weight requirement of 70 lb. per cubic foot, compacted, as lighter slags have not been generally satisfactory as concrete aggregate.

TABLE I.—COMPRESSIVE STRENGTH OF CONCRETE CORES EQUATED AT 28 DAYS, PAVEMENT CONCRETE 1:5½ MIX

Year	Coarse Aggregate	Number of Tests: Plaster of Paris Caps	Number of Tests: Leadite Caps	Compressive Strength in Lbs. Per Sq. In.: Plaster of Paris Caps	Compressive Strength in Lbs. Per Sq. In.: Leadite Caps
1932	Gravel	1,326	...	3,100	.....
	Limestone ...	740	...	3,040	.....
	Slag	756	...	3,220	.....
1933	Gravel	564	701	3,229	4,704
	Limestone ...	249	285	3,105	3,900
	Slag	181	56	3,080	4,742

Our specifications for concrete make no distinction as to kind of coarse aggregate. Both fine and coarse aggregate are proportioned by weight of dry, loose material. Coarse aggregate shall be thoroughly wet before being batched, if in the opinion of the engineer it is necessary to obtain concrete of uniform consistency. This is almost universally necessary with slag, as the absorption of slag varies over a much wider range than either limestone or gravel.

Further, when slag is used, the batching equipment shall be so constructed and adjusted that the volume of the coarse aggregate shall not exceed the volume designated in the job mix as some variation in the unit weight of slag may be expected even from the same source.

Natural sand and limestone sand are permitted under our specification as fine aggregate for portland cement concrete. We have no specification for slag sand for portland cement concrete. So far as I know slag producers have not yet entered this field. The slag sand included in this summary is a comparatively fine sand which is required in certain grades of bituminous concrete.

There is more variation between the average weights of slag than for limestone and gravel. One must be alert to this fact in using slag as a concrete aggregate.

The compressive strength, equated at 28 days, of concrete cores cut from our concrete pavement during 1932 and 1933 is shown in Table I. It happened during 1933 we adopted the practice of capping our cores with Leadite so that for that year we have results with two methods of capping. While not related to a talk on slag, the increase in strength which accompanied the use of Leadite caps may interest laboratory men.

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COMPARATIVE MAINTENANCE COST STUDIES TO BE MADE—The Bureau of Public Roads is making arrangements for comparative maintenance cost studies on selected sections of modern highways in the various states. Up to Jan. 1 27 states had started the study, two had selected sections for approval and 13 had signified their probable cooperation. The 29 states have selected sections consisting of the following surfaces: Concrete 3,968 miles; Brick 142 miles; Bituminous 1,838 miles; Oil Processed 1,283 miles; Surface Treated 1,092 miles; Untreated Stone, Gravel, Sand-Clay, etc., 2,205 miles; Topsoil 133 miles; Graded 59 miles.

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NATIONAL TRACTOR AND INDUSTRIAL POWER EQUIPMENT MEETING—Renewed activity in the agricultural and industrial equipment field has led to the reorganization of the S. A. E. Tractor and Industrial Power Equipment Committee. As a result of this activity the first national meeting will be held April 18 and 19 at the Hotel Pfister, Milwaukee, Wis.

Year-Round Employment In Highway Work

By T. Warren Allen

Chief Division of Management, U. S. Bureau of Public Roads

Highway construction work, except in a very few of the states, has long been held to be a seasonal activity from the viewpoint of both the highway contractor and the highway engineer. In fact, the greater part of our construction practices and specification requirements have been developed on the basis of the prevailing weather and soil conditions encountered during the usual normal construction season. During the past three or four years, however, there has been an increasing insistence from many sources that highway construction work be carried on as a continuous year-round activity so as to absorb the greatest possible amount of labor during the annual period when unemployment is generally at its maximum. An interesting discussion of the problems in extending the highway construction was given by T. Warren Allen in a paper presented at the recent meeting of the Association of Highway Officials of the North Atlantic States. His paper follows.

WHILE considerable progress has been made in extending the usual working season and much valuable experience has been gained, both engineers and contractors are still unagreed as to what changes or modifications, if any, should be made in our standard specification requirements as to methods of operation and details of field practice for winter work, and as to the effect of conditions during that season on quality, production rates, and unit costs.

Seasonal Variations in Employment.—A brief reference to seasonal variations in the amount of employment in the highway construction field will serve to give an idea of the extent to which the highway construction industry must change its past practices if it is to become permanently a uniformly distributed, year-round industry. For this purpose the employment data on state and federal highway construction work for the years 1931 and 1932 will serve as a very conservative measure, for even in these years considerable effort was being made to increase winter construction activities.

In this field, as shown in Table I, in 1931, the total employment in the United States varied from a minimum of about 79,900 in January to about 277,000 in July—a divergence of more than 3 to 1. In 1932, the total employment was considerably less but still varied from a minimum of about 79,700 in March to a maximum of about 219,300 in September. This is still a divergence which approaches the ratio of 3 to 1.

In individual states the seasonal fluctuations in the amount of employment on state and federal-aid highway work seem to vary both with the climatic conditions and with the funds available and with the direct efforts made to extend construction activities into the off season. Thus while in 1931 the state highway employment in New Jersey fluctuated only from 2,000 in February to 4,035 in August, and in 1932 from 1,985 in February to 3,370 in November, the corresponding variations in the state of New York, with its more rigorous climate coupled with a decrease in available road funds, was from 1,375 in February to 19,329 in August, 1931, and from 1,262 in March to 14,712 in September, 1932. New Jersey thus had a maximum peak summer employment of from about two to three times the minimum winter employment, while in New York the maximum summer employment exceeded the minimum winter employment on its state highway construction work by from 12 to 14 times.

For the United States as a whole the seasonal variation in the number of men employed on state highway maintenance work is not so marked, the fluctuations ranging only about 68,700 in January, 1931, to 134,000 in December, and from 129,000 in June, 1932, to 160,700 in November. This is a divergence of less than 2 to 1 in either year. In certain individual states, however, the divergence is much greater. Thus in Pennsylvania we note, in 1931, a minimum employment of 5,702 in January and a maximum of 28,544 in December, and in 1932 the minimum employment was reached at 17,084 in March from whence it increased to 50,222 in November.

Inclement Weather Basic Cause of Labor Fluctuation.—The basic cause of most of this seasonal fluctuation in our highway employment is the increased difficulty of carrying on this work in inclement weather. Rain, snow, cold and wet or frozen ground all present difficulties which tend to decrease production and increase unit costs, and frequently prevent entirely the performance of any useful work. In some kinds of work there is also the added danger that quality might be impaired. We thus frequently have conditions in which the engineering and inspection forces insist on extreme rigidity in the interpretation and enforcement of specification details in their laudable efforts to insure quality, while the contractor often finds that certain details of procedure well adapted to good weather or summer operation are extremely difficult or even impossible to perform under certain soil or weather conditions. The next result of these conditions too frequently proves unfortunate to both the contractor and the engineer.

Problem for Both Engineer and Contractor.—The problem of extending the season of our highway construction work is therefore one for both the engineer and the contractor. For inclement weather or winter work the engineer must give much more study to the writing of all those specification details which control methods of operation and procedure. Moreover, this study must be made in the same light and from the same viewpoint with which he has so long studied these same details when they were intended only for operating under normal weather and soil conditions—namely, that of facilitating production and improving quality. At present the most pressing questions seem to be mainly those connected with finding such ways and means as are adapted

TABLE I.—MAXIMUM SEASONAL VARIATION IN STATE HIGHWAY EMPLOYMENT IN NORTH ATLANTIC STATES DURING THE CALENDAR YEARS 1931 AND 1932

State	CONSTRUCTION								MAINTENANCE							
	1931				1932				1931				1932			
	Maximum	Month	Minimum	Month	Maximum	Month	Minimum	Month	Maximum	Month	Minimum	Month	Maximum	Month	Minimum	Month
Connecticut	3,071	Oct.	318	Feb.	3,233	Nov.	237	Mar.	1,009	June	934	Dec.	1,005	Sept.	939	Dec.
Delaware	1,167	Sept.	139	Jan.	1,739	Nov.	506	Aug.	171	Dec.	97	Mar.	261	Nov.	120	Dec.
Maine	6,982	Aug.	324	Feb.	12,755	Aug.	239	Mar.	1,299	Jan.	562	Mar.	1,833	May	682	Nov.
Maryland	4,484	Oct.	672	Feb.	3,529	Aug.	1,162	Feb.	2,071	July	1,577	Jan.	3,539	Dec.	1,916	Jan.
Massachusetts ..	7,425	Sept.	901	Feb.	3,968	Sept.	938	Mar.	1,621	Dec.	988	Apr.	2,557	Apr.	1,226	Aug.
New Hampshire	3,155	Nov.	125	Mar.	8,203	Nov.	62	Mar.	5,326	Nov.	253	Mar.	3,159	Feb.	793	Apr.
New Jersey.....	6,035	Aug.	2,000	Feb.	3,370	Nov.	1,985	Feb.	4,075	Dec.	1,347	Sept.	4,835	Feb.	1,095	June
New York.....	19,329	Aug.	1,375	Feb.	14,712	Sept.	1,262	Mar.	6,570	Mar.	1,871	Dec.	10,025	Apr.	4,273	Nov.
Pennsylvania ...	12,666	Aug.	681	Dec.	9,129	Nov.	172	Feb.	28,544	Dec.	5,702	Jan.	50,225	Nov.	17,084	Mar.
Rhode Island...	1,277	May	17	Feb.	884	Sept.	93	Mar.	684	Feb.	439	Sept.	1,404	Mar.	785	Aug.
Vermont	1,832	Aug.	53	Feb.	1,840	Dec.	235	Mar.	2,136	June	47	Feb.	1,396	July	247	Mar.
United States...	277,346	July	79,900	Jan.	219,277	Sept.	78,707	Mar.	134,437	Dec.	68,700	Jan.	160,728	Nov.	129,019	June

TABLE II.—SUMMARY OF AVERAGE TIME LOSSES ON 24 POWER SHOVEL GRADING JOBS—12 JOBS OPERATED DURING WARM SEASON AND 12 OPERATED DURING COLD SEASON.

Cause of delays	Warm season jobs	Cold season jobs
Major Time Losses (each stop of 15 minutes or more in duration):	Percentage of calendar working time lost	
Weather	3.1	18.6
Shovel trouble and repair	5.4	6.4
Shovel moving	1.7	3.6
Management and dependent operations	2.8	5.4
Total	13.0	34.0
Minor Time Losses (each stop of 15 minutes or less in duration):	Percentage of actual working time lost	
Hauling operations	6.6	15.0
Shovel operation	8.9	9.6
Management and dependent operations	9.9	13.5
Total	25.4	38.1
Production, cubic yards per working hour	124	85[1]

[1]Note: Average rate when two extra low production jobs are omitted; otherwise average is only 70 cu. yd. per hour.

TABLE III.—SUMMARY OF AVERAGE TIME LOSSES ON 20 CONCRETE PAVING JOBS—10 JOBS DURING USUAL PAVING SEASON AND 10 JOBS OUTSIDE OF REGULAR SEASON.

Cause of delays	Usual season jobs	Off-season jobs
Major Time Losses (each stop of 15 minutes or more in duration):	Percentage of calendar working time lost	
Weather	5.5	38.7
Operations and management	10.9	12.9
Total	16.4	51.6
Minor Time Losses (each stop of 15 minutes or less in duration):	Percentage of actual working time lost	
Hauling operations	3.5	10.4
Mixer operations	2.0	4.2
Preparing subgrade	0.8	4.7
Management and dependent operations	3.3	6.3
Total	9.6	25.6
Average production, batches per working hour	46	33

to facilitating production rates under what we might call off-season conditions for highway construction work without in any way endangering the quality of the finished product.

Low production rates inevitably mean high production costs. If the working season can be measurably extended, certain of the contractor's overhead costs will tend to decrease, but the effect of these on the final unit costs is apt to be relatively small. We must therefore find our main justification for extending the active construction season into the inclement weather season either in our ability to keep unit construction costs fairly close to those of the normal construction season or else we must determine that the social value of having highway employment extended more evenly throughout the year is sufficient to balance the extra cost involved.

The extent to which inclement weather tends to delay highway construction activities and reduce production rates is a question on which we have far too little definite data. A somewhat detailed analysis of 24 power shovel grading jobs and 20 concrete paving jobs will serve, however, to illustrate something of the actual hardships which seasonal weather conditions impose on the road builder. One-half of the jobs of each group was carried on during the good or normal working season while the other half was carried on during the off or inclement weather season. All of the jobs were actively pushed. Equipment and management were average or better on each of them. It should be remembered in the comparisons made that the off season includes only the time during which work is in progress. Particularly in the northern states, the off season usually is but part of the winter season, the other part being time during which, because of unfavorable weather or soil conditions, no work was done at all.

Effect of Weather Conditions on Power Shovel Grading.—Power shovel grading work is often considered to be but little affected by weather conditions. The data from these 24 jobs, however, tend to refute this belief. Thus, while the summer season jobs lost an average of but 13 per cent of the available calendar hours in definite stops or delays each of more than 15 minutes in duration, the winter or off-season jobs lost an average of 34 per

cent of the available time, as shown in Table II. The off-season jobs were therefore forced to remain definitely idle for more than one-third of the calendar time. The most striking difference between the two groups is, of course, due to weather, which includes rain, snow, cold and too wet or soft ground or grade. For the normal-season jobs this item averaged only 3.1 per cent of the available time, but for the off-season jobs the weather forced a loss of 18.6 per cent of the available time. The amount of time lost from other causes was also much greater on the off-season jobs. Shovel repairs and shovel troubles were increased from 5.4 to 6.4 per cent. Moving the shovel from cut to cut consumed an average of only 1.7 per cent of the time on the normal-season jobs, but required 3.6 per cent—more than twice as much time —for the off-season jobs. All other non-productive operations and causes required 2.8 per cent of the available time on the normal-season jobs and 5.4 per cent for the off-season jobs.

In addition to these longer definite stops or delays, every job is subject to a varying amount of minor delays or interruptions to continuous operation. On the normal-season jobs these minor delays or interruptions sufficed to keep the shovel unproductive for an average of 25.4 per cent of the time the crew was out on the job and attempting to work. On the off-season jobs, however, the shovel was unproductive 38.1 per cent of the working time. For the normal-season and off-season jobs these minor time loss totals were made up respectively of the following percentages:

	Per Cent
Hauling operations	6.6 and 15.0
Shovel operations	8.9 and 9.6
Dependent operations and other causes	9.9 and 13.5

TABLE IV.—MAJOR TIME LOSSES—POWER SHOVEL GRADING WORK—WINTER OPERATION.
(Time Losses Shown in Per Cent.)

Project No.	1	2	3	4	5	6	7	8	9	10	11	12	Average
Rain, snow and cold	10.7	2.3	14.1	11.1	5.2	3.6	10.5	12.3	14.7	20.8	25.4	17.5	12.4
Wet grade	5.0	13.2	1.9	...	...	0.8	19.6	15.0	0.6	10.1	4.8	2.8	6.2
Hauling equipment	0.2	0.1	3.3	0.3	...	...	0.1	0.7	1.2	...	...	...	0.5
Shovel—													
Moving	11.2	5.2	1.3	1.4	1.0	1.0	3.6	2.8	4.4	5.4	3.2	2.6	3.6
Repair	2.7	5.9	4.3	9.9	8.4	6.4	0.8	3.8	1.7	2.3	1.2	0.5	4.0
Cable	0.2	0.4	0.2	...	0.3	0.7	2.0	0.7	...	...	...	...	0.4
Engine	2.2	...	10.1	...	0.5	6.6	1.7	0.2	...	0.5	...	2.8	2.0
Rocks, roots and stumps	0.1	...	...	...	...	...	0.8	0.6	...	...	...	...	0.1
Blasting and drilling	0.4	4.7	1.1	8.9	4.9	6.0	0.4	...	...	1.0	0.1	0.5	2.3
Water or fuel	0.2	1.2	0.7	0.2	0.3	...	...	1.3	0.4	...	...	...	0.4
Sloping and grading	...	2.1	...	1.7	...	...	...	...	2.0	...	...	...	0.5
Miscellaneous	0.7	0.3	4.8	...	4.8	2.0	0.1	0.6	6.2	0.2	0.5	...	1.6
Totals	33.6	35.4	41.8	33.5	25.4	27.1	39.6	38.0	31.2	40.3	35.2	26.7	34.0
Average production, cubic yards per working hour	80	45	60	100	57	47	83	68	62	113	133	90	70

TABLE V.—MINOR TIME LOSSES—POWER SHOVEL GRADING WORK—WINTER OPERATION.
(Time Losses Shown in Per Cent.)

Project No.	1	2	3	4	5	6	7	8	9	10	11	12	Average
Hauling units—													
Supply	5.1	9.1	17.0	14.8	4.5	6.7	9.5	15.1	3.1	10.0	6.1	14.9	9.7
Operation	2.5	8.1	3.8	2.6	1.3	8.6	3.0	13.5	10.0	1.9	3.4	4.5	5.3
Shovel—													
Moving	6.6	5.5	7.3	8.4	7.4	3.8	3.8	6.9	5.1	3.3	3.3	5.1	5.4
Repairs	1.6	1.3	1.4	1.2	2.4	2.5	0.9	4.2	2.1	3.2	1.6	0.5	1.9
Engine trouble	0.7	0.3	0.5	0.3	0.4	1.0	1.8	...	...	1.3	1.7	0.2	0.7
Operator	1.8	1.2	4.5	2.0	0.4	2.4	1.0	0.8	1.2	1.4	1.9	0.7	1.6
Drilling and blasting	0.4	0.4	2.0	...	1.4	0.2	...	...	...	...	...	...	0.4
Rocks, roots and stumps	7.9	4.0	4.1	1.7	15.5	4.6	4.2	0.5	2.2	8.4	6.6	2.2	5.1
Check grade	...	0.2	0.6	0.3	...	...	...	...	...	...	...	...	0.1
Sloping	4.3	2.7	0.7	9.1	10.5	2.7	1.2	6.6	11.7	...	...	3.7	4.4
Smoothing grade	...	...	...	...	...	...	...	7.7	12.4	...	...	...	1.7
Wet ground or frost	0.7	...	...	0.7	...	0.7	2.2	...	...	...	...	...	0.4
Miscellaneous	0.2	0.3	2.9	1.3	2.4	0.7	0.8	0.4	0.7	3.0	2.5	1.4	1.4
Totals	31.8	33.1	44.8	42.4	46.2	33.9	28.4	55.7	48.5	32.5	27.1	33.2	38.1
Average shovel cycle, sec.	29.5	29.5	24.1	24.3	25.4	23.8	25.9	17.6	22.5	23.7	22.2	17.3	23.8
Size of shovel, cu. yds.	1¼	1	1¼	1½	1½	1¼	1¼	1	1¼	1½	1½	1	...

TABLE VI.—MAJOR TIME LOSSES—POWER SHOVEL GRADING WORK—SUMMER OPERATION.
(Time Losses Shown in Per Cent.)

Project No.	13	14	15	16	17	18	19	20	21	22	23	24	Average
Rain	4.6	4.8	6.7	7.7	...	3.5	...	...	...	...	3.2	...	2.6
Wet grade	0.1	3.4	...	...	...	0.4	...	...	...	...	1.8	...	0.5
Hauling equipment	...	...	...	1.7	...	...	...	...	...	...	1.1	...	0.2
Shovel—													
Moving	0.1	1.2	0.1	0.8	...	2.8	1.0	0.6	2.0	3.4	2.5	4.4	1.7
Repairs	0.6	0.5	0.2	0.6	9.6	4.2	8.6	4.3	7.6	14.6	6.8	0.4	4.8
Engine trouble	...	...	...	...	...	...	...	...	...	0.5	...	0.7	0.1
Cable	0.1	...	...	0.1	0.3	...	1.1	...	...	...	0.4	...	0.2
Water and fuel	0.1	...	...	...	0.2	...	...	2.5	...	...	...	0.2	0.3
Rocks, roots and stumps	...	...	...	...	...	...	...	9.7	2.2	...	...	...	1.0
Drilling and blasting	0.1	...	1.9	0.3	...	...	...	1.5	...	...	0.8	...	0.4
Sloping and grading	...	7.2	2.1	...	...	...	0.5	0.8	...	...	...	0.4	0.4
Management	...	...	...	0.7	...	...	...	...	5.6	...	...	...	0.5
Miscellaneous	0.1	...	...	0.4	...	...	1.0	...	0.4	0.3	1.4	...	0.3
Totals	5.8	17.1	11.0	12.3	10.1	10.9	12.2	19.4	17.8	18.8	17.9	6.1	13.0
Average production, cubic yards per working hour	128	150	150	152	90	168	99	156	68	88	110	133	124

TABLE VII.—MINOR TIME LOSSES—POWER SHOVEL GRADING WORK—SUMMER OPERATION.
(Time Losses Shown in Per Cent.)

Project No.	13	14	15	16	17	18	19	20	21	22	23	24	Average
Hauling units—													
Supply	1.6	1.0	2.1	9.4	9.8	1.3	0.7	6.4	12.0	10.5	5.0	1.4	5.1
Operation	0.5	0.6	0.7	1.9	0.4	1.2	3.2	4.4	0.7	1.3	2.2	1.3	1.5
Shovel—													
Moving	3.4	5.5	5.4	4.0	2.9	10.0	4.5	2.7	6.5	5.7	6.1	6.1	5.2
Repairs	0.4	1.5	0.5	1.5	1.6	1.2	1.6	1.4	3.8	0.2	1.8	3.1	1.6
Engine trouble	1.6	0.7	1.8	1.5	1.5	0.3	...	...	0.6	0.9	1.0	0.5	0.9
Operator	0.2	1.2	0.2	1.1	2.1	0.5	0.7	0.7	2.1	2.2	2.1	0.8	1.2
Drilling and blasting	0.6	...	0.3	...	...	...	...	...	...	...	...	...	0.1
Rocks, roots and stumps	9.9	0.9	6.3	2.9	0.3	0.4	13.7	2.8	3.8	3.4	1.8	1.3	4.0
Sloping	0.3	6.8	0.5	...	...	5.2	3.0	1.5	...	...	...	3.9	1.8
Smoothing grade	3.1	...	4.5	...	2.7	2.7	...	4.5	2.9	3.6	2.0	5.4	2.2
Wet ground	...	2.7	...	...	...	0.2	...	1.2	...	...	...	...	0.3
Check grade	...	...	...	...	...	...	0.02	...	...	0.7	...	0.3	0.1
Miscellaneous	0.5	...	1.0	2.8	1.2	0.1	...	1.7	2.5	1.6	3.7	1.0	1.4
Totals	22.1	20.9	23.3	25.1	22.5	23.1	27.4	27.3	34.9	30.1	25.7	25.1	25.4
Average shovel cycle, sec.	17.6	19.3	16.1	16.7	18.3	15.9	27.2	25.3	21.9	23.2	21.0	19.8	20.2
Size of shovel dipper, cubic yards	1¼	1¼	1¼	1¼	¾	1¼	1¾	2¼	1	1¼	1¼	1¼	...

TABLE VIII.—MAJOR TIME LOSSES—CONCRETE PAVING—WINTER AND EARLY SPRING OR LATE FALL OPERATION.
(Time Losses Shown in Per Cent.)

Project No.	11	12	13	14	15	16	17	18	19	20	Average
Rain	4.2	22.6	3.3	6.4	7.6	19.0	8.3	8.5	27.2	11.4	11.9
Wet grade	10.3	28.8	19.6	27.0	17.2	12.0	19.5	19.5	29.3	33.0	21.6
Cold weather	...	11.3	0.8	1.1	...	...	8.5	20.1	...	10.7	5.2
Mixer—											
Mechanical	0.5	...	2.0	2.5	0.5	4.2	1.1	1.6	0.2	0.9	1.3
Moving	8.4	...	...	0.3	...	0.7	7.3	2.2	1.8	7.1	2.8
Materials, lack of	1.1	0.8	...	0.1	9.1	1.9	0.8	1.1	1.0	1.0	1.7
Subgrade	1.6	0.7	6.5	4.4	3.3	2.0	...	1.2	...	0.3	2.0
Water supply	1.3	0.9	2.3	0.9	...	4.4	0.4	1.1	1.2	0.2	1.3
Finishing	0.3	...	2.5	1.3	2.5	0.9	0.1	...	0.1	...	0.8
Batching plant	...	0.6	...	...	...	...	...	...	...	...	0.1
Hauling	0.1	0.2	0.4	1.1	...	...	0.8	0.5	...	0.4	0.3
Miscellaneous	0.4	0.6	2.0	0.5	4.4	8.0	4.6	3.6	1.8	0.5	2.6
Totals	28.2	66.5	39.4	45.6	44.6	53.1	51.4	59.4	62.6	65.5	51.6
Average production, batches per working hour	42	34	26	30	33	32	37	29	35	33	33
Average mixer cycle, sec.	64.7	89.0	92.0	92.4	78.0	78.0	72.0	80.4	71.9	95.0	81.5

The most striking difference, however, is in the actual production secured per hour that the crew was out on the job. The average production of the twelve normal-season jobs was 124 cu. yd. per hour as compared with 85 cu. yd. for the off-season jobs. The off-season jobs thus not only were forced to be idle 34 per cent of the available calendar working time as against 13 per cent for the normal-season jobs, but when they did operate their rate of production was about 32 per cent less than for the normal-season jobs.

These figures are only indications of trends since 24 jobs are insufficient to determine a definite measure of the average variation between normal and off-season work. Nor was the equipment, management, materials, etc., identical. Every grading job is a problem by itself. It is believed, however, that these data are sufficient to indicate a serious handicap against off-season work which deserves serious consideration in order to determine how and to what extent it can be reduced.

The Handicap of Inclement Weather and Soil Conditions in Paving Work.—On paving work inclement weather and the soil conditions which usually accompany such weather present a still greater handicap to off-season operation. With present methods and requirements such work as concrete paving is definitely impossible, except in the most restricted sense, in many of our states during a considerable time each winter. In some regions even work during early spring or late fall presents many difficulties.

Table III gives the summary of an analysis of 20 concrete paving jobs, ten of which were conducted during the summer season or more favorable normal paving season and ten during the inclement weather season. Here we find that, while the normal-season jobs lost only 5.5 per cent of the available calendar working time in definite stops or delays each of more than 15 minutes in duration from weather causes, the off-season jobs suffered a loss more than seven times greater or an average loss of 38.7 per cent. On the normal-season jobs the mixer was definitely idle only about one-sixth of the available time while on the off-season jobs the mixer was idle more than one-half of the time.

But, this was only a part of the handicap which the off-season jobs had to carry. While the crew was out on the job and actively endeavoring to operate, minor delays and interruptions kept the mixer from pouring concrete during 25.6 per cent of the time on the off-season jobs as compared with an average of only 9.6 per cent for the normal-season jobs. The net rate of production during the actual working time was also somewhat slower on the off-season jobs due to a tendency to permit the mixer cycle to increase unnecessarily in cold or disagreeable weather. The actual difference of 46 batches per working hour for the normal-season jobs as compared with an average of only 33 batches per hour for the off-season jobs is due first to the fact that the normal-season jobs utilized all but 9.6 per cent of their working time in actually pouring concrete as against an average loss of 25.6 per cent for the off-season jobs and, secondly, to the fact that the required mixing time was considerably longer on a few of the off-season jobs. For the normal-season jobs the average mixer cycle was 71.9 seconds as compared to 81.5 seconds for the off-season jobs. Had the mixing time requirements been as low for the off-season jobs as for the others, their time loss would no doubt have been considerably more than the

present 25.6 per cent. Under such trying conditions as those met with in off-season work, it is much more difficult to maintain a short mixer cycle than a long one.

The Highway Industry Confronted with Difficult Problem.—If these rather random examples are reasonably representative of the difficulty of carrying on off-season highway construction work, and it is believed they are, the highway profession is confronted with a difficult question and one which must be faced squarely and frankly. The public insistence on a more uniform distribution of highway activities throughout the year is increasing rather than diminishing. In part, this demand can be met through a further extension of maintenance work during the winter months, but this will probably be far from sufficient by itself. We therefore have the problem of deciding whether we shall have to carry on our increased winter construction work at a considerable cost over and above that for the same work performed during the summertime, or whether we shall be able to develop such means and methods as will permit winter work to be performed more nearly at summer costs.

The highway profession, and in fact the entire highway industry, must unite in finding ways and means of reducing winter construction costs and increasing the amount of winter highway work. The maintenance field can, no doubt, help us to some extent. Certain kinds of road betterment work can also be performed nearly as readily under winter or off-season conditions as during the normal or usual construction season. This applies with special force to such roads as carry a very dense traffic during the summer but only a light traffic in winter.

More Careful Selection of Off-Season Projects Might Help.—Another possibility is a more careful or an advance selection of those projects intended for construction during the summer and those intended for construction during the winter or off-season. This will require a more detailed study of soil conditions on the particular projects and the probable weather conditions which may

TABLE IX.—MINOR TIME LOSSES—CONCRETE PAVING—WINTER, EARLY SPRING AND LATE FALL OPERATION.

(Time Losses Shown in Per Cent.)

Project No.	11	12	13	14	15	16	17	18	19	20	Average
Trucks—											
Supply	0.9	5.0	4.4	9.0	2.5	5.8	7.9	8.1	19.5	7.5	7.1
Operator	1.3	1.7	0.8	2.8	2.2	0.8	1.6	1.5	0.2	0.9	1.4
Dumping	0.4	...	4.1	...	2.3	3.2	1.8	2.2	3.3	1.5	1.9
Mixer—											
Mechanical	2.3	0.6	4.3	3.1	0.7	3.8	0.9	1.6	1.4	0.5	1.9
Operator	10.3	0.9	1.1	3.0	1.7	2.2	0.7	1.7	0.5	0.5	2.3
Water supply	0.3	1.9	3.4	0.6	1.3	9.8	1.6	2.5	0.1	0.8	2.2
Subgrade	7.0	3.2	7.5	2.3	7.0	3.0	0.7	6.5	2.8	7.5	4.7+
Finishing	...	...	...	0.4	...	0.1	0.4	...	...	...	0.1
Setting steel or joints	0.7	...	...	0.2	3.2	0.1	5.7	1.5	...	...	1.1
Materials, handling	0.5	1.0	...	0.4	...	...	...	...	...	0.3	0.2
Miscellaneous	1.2	1.4	2.2	0.6	5.0	0.8	5.0	5.8	1.2	3.8	2.7
Totals	24.9	15.7	27.8	22.4	25.9	29.6	26.3	31.4	29.0	23.3	25.6

TABLE X.—MAJOR TIME LOSSES—CONCRETE PAVING—USUAL PAVING SEASON.

(Time Losses Shown in Per Cent.)

Project No.	1	2	3	4	5	6	7	8	9	10	Average
Rain	0.5	1.1	3.9	2.1	4.1	1.9	7.4	1.0	1.5	1.5	2.5
Wet grade	...	2.3	9.5	5.3	...	...	3.5	3.7	0.1	5.2	3.0
Mixer—											
Mechanical	0.8	0.5	2.0	0.6	...	1.9	1.6	3.8	1.5	1.0	1.4
Moving	7.5	2.2	1.9	4.7	2.2	6.1	4.8	0.8	0.2	7.4	3.8
Materials, lack of	0.2	...	...	...	4.3	...	...	...	...	2.1	0.7
Subgrade	...	0.9	1.6	...	...	0.5	0.1	...	...	3.2	0.6
Water supply	0.6	1.5	0.2	0.2	...	1.1	0.1	2.3	3.7	2.7	1.2
Finishing	0.4	0.1	0.1	...	0.1	0.2	...	...	1.1	0.4	0.2
Batching plant	1.2	0.1	0.7	...	2.2	...	0.3	...	...	3.9	0.8
Hauling	...	0.1	...	...	...	...	0.2	...	0.2	...	0.0
Miscellaneous	0.5	0.1	0.5	4.3	...	6.4	4.3	4.1	0.5	0.7	2.2
Totals	11.7	8.9	20.4	17.2	12.9	18.1	22.3	15.7	8.8	28.1	16.4
Average production, batches per working hour	41	48	45	45	55	45	40	48	47	46	46
Average mixer cycle, sec.	80.8	61.3	70.7	73.3	63.6	72.2	87.0	68.5	70.7	70.8	71.9

TABLE XI.—MINOR TIME LOSSES—CONCRETE PAVING—USUAL PAVING SEASON.

(Time Losses Shown in Per Cent.)

Project No.	1	2	3	4	5	6	7	8	9	10	Average
Trucks—											
Supply	2.2	1.2	0.9	2.3	2.3	0.9	0.4	2.2	0.4	1.3	1.4
Operation	3.9	0.4	0.8	0.2	0.6	0.9	1.2	1.6	2.2	0.9	1.3
Dumping	1.4	4.0	0.7	...	...	0.8	...	0.1	...	0.8	0.8
Mixer—											
Mechanical	0.1	0.4	1.2	1.1	...	0.7	0.8	0.7	0.4	1.1	0.6
Operator	2.7	3.0	1.7	1.7	0.3	0.4	0.3	1.4	1.3	0.4	1.4
Water supply	2.1	0.4	2.5	1.7	1.0	1.3	0.3	2.6	0.8	1.5	1.4
Subgrade	0.2	2.8	...	...	...	1.3	0.3	...	...	3.2	0.8
Finishing	0.7	...	...	...	...	0.3	...	...	...	...	0.1
Setting steel or joints	...	3.2	0.3	...	...	...	0.2	...	...	0.9	0.5
Handling materials	...	...	...	...	...	...	0.2	...	...	...	0.0
Batching plant	...	...	...	...	3.4	...	...	...	...	...	0.3
Lip curb	...	0.7	1.0	...	...	...	...	...	...	...	0.2
Miscellaneous	1.8	0.6	1.9	1.3	0.1	0.9	0.3	0.0	1.5	0.2	0.8
Totals	15.1	16.7	11.0	8.3	7.7	7.5	4.0	8.6	6.6	10.3	9.6

be expected while the work is under way. Such factors as the kind and character of the soil, the amount and distribution of the precipitation, as well as the probable temperatures and how these may be expected to vary, will probably have an influence in many cases in determining whether a project should be let for normal or for off-season construction.

The problem of laying pavement is much more difficult than for doing grading. It may be possible in the case of grade-crossing elimination to house-in the work for protection against inclement weather conditions. Research may develop the feasibility in some sections of an advance selection of certain roads for winter work, protecting the subgrade by a covering of some sort against cold which would be detrimental and on such protected subgrade to lay a pavement similarly protected. In fact, some work is being done during the present winter along this line and the experience thus gained should be of value. Such a procedure would probably considerably increase unit costs. In this connection it should be borne in mind that during periods of acute unemployment, those without means must be fed, and if the funds for this purpose can be utilized in the production of a worthwhile utility, the work provided will enable those needing relief to secure it without sacrifice of self-respect. In all this work, however, the main and guiding purpose must be the performance of off-season highway work of a quality not appreciably different from that obtained during the usual normal construction season and at a cost commensurate with the value received. The details of the problem will, of course, be different for every state, but it is a live problem and one worthy of our most serious consideration.

It is foolish to say anything is impossible. Many so-called impossibles of yesterday are today generally accepted procedures. When necessity drives, practically all obstacles may be overcome. The genius of the American people is equal to any task. The time has now come when necessity bids us to continue highway construction throughout the winter months and, within reason, will be done.

▼

Use of Cost-Control Chart in Refuse Removal

A chart that has proved very useful to the Bureau of Street Cleaning of Newark, N. J., in controlling the costs of refuse removed was described by John S. Flockhart, Assistant Engineer of the Bureau, at the last annual convention of the International Association of Public Works Officials. The chart is intended as a visible method of showing each week how the cost of removing refuse is trending and may be used as a warning or guide for future operations. The chart is plotted on ordinary cross section paper with the cost per cubic yard as an ordinate and the week number as an abscissa.

Data are compiled at the end of each week from the daily report sheets. The items used are (1) The number of man days of labor used in bringing material from the back yard to the curb. (2) The number of man days of labor used in loading the material onto the truck or team wagons. (3) The number of truck days and team days of equipment.

Labor is paid for at the rate of $4.56 per day, the cost of a truck is set at $25 per day and the cost of a team at $9 per day. This cost is divided by the number of cubic yards of material collected and the cost arrived at per cubic yard. The cost per week is then plotted on the chart which has been used since 1929. A rising curve means that for the amount of refuse collected in that particular work, more men or equipment were used than in the preceding weeks and a greater effort is made to regulate the equipment or labor for the coming week. It is an easy matter to calculate with the slide rule the cost per cubic yard for each operation in every one of the 16 refuse districts with not more than three hours of office work weekly.

The official then knows, for instance, the cost of removing material from the back door, of loading on wagon or truck, and the cost of hauling in any district. He is also able to compare performances of the same districts for different weeks or different districts for the same week. A marked increase in the unit cost of any one of the services is his warning to reduce.

This method is intended primarily as a control and not as an exact method of cost. For instance, the cost of trucks is arbitrarily given as $25 per day and the cost of teams as $9 per day, while as a matter of fact, the costs are usually above or below these amounts. If, however, these costs be taken as constant, and the labor equipment as variable, the idea of comparison can be successfully carried out.

It has proved to be very successful for several years as an aid and guide in lowering the costs. With the cooperation of the superintendent and assistant superintendents, who are very much interested in watching the ups and downs of the costs, it gives an excellent idea of the efficiency of the organization.

▼

Progress on Public Works Highways.—Progress made on emergency construction of public works highways to March 24 under the supervision of the U. S. Bureau of Public oRads shows a total of 6,742 projects, estimated to cost $339,637,000, had been advertised for contract, begun by day labor employed directly by the highway authorities, or completed. The cost of the day labor projects included in the above is estimated at $23,887,000. Of the 5,997 projects awarded for construction, 3,948 were under construction on March 24, and 825 were completed.

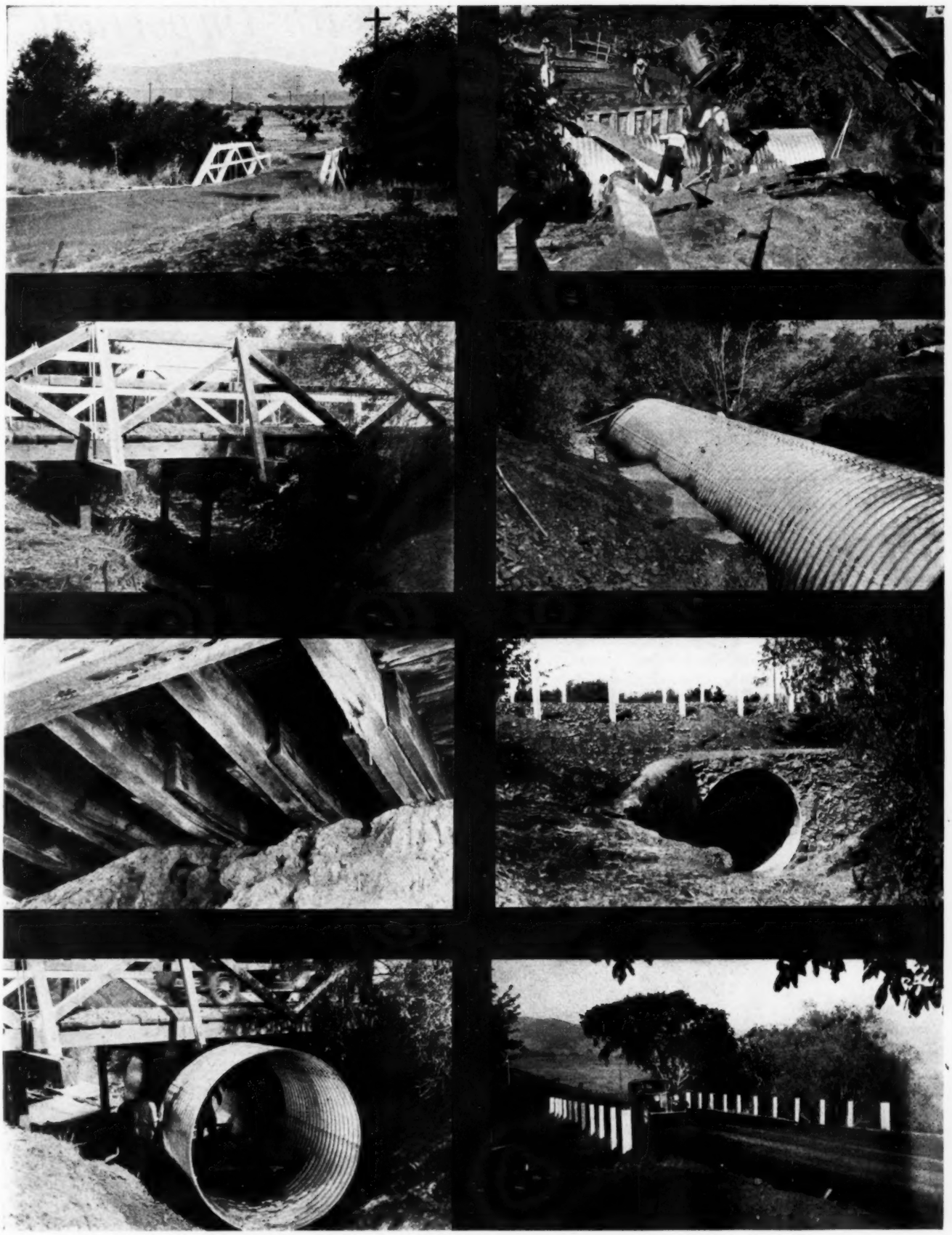
▼

Unsafe Wooden Structure Replaced in Record Time

Motorists who had carefully negotiated the narrow wooden bridge shown in photo one on the opposite page on the way to make an overnight visit to friends in a nearby city, were afforded a pleasant surprise on their return when they found the structure gone and in its stead a safe and comfortable roadway.

This Aladdin-like improvement was effected, not by a kindly genie working in the night, but by the none the less effective road crew of Contra Cost County, California, under the direction of Supervisor Harry N. Stow and County Engineer R. R. Arnold. The replacement of the structure with a 105-in. diameter Armco multiplate, 45 ft. long, made it necessary to close the road for only 24 hours. During this period the old bridge was removed and backfill placed. The large culvert had previously been assembled under the old bridge in 14 hours without disturbing traffic. Mr. Stow's personal attention was very effective in expediting the work.

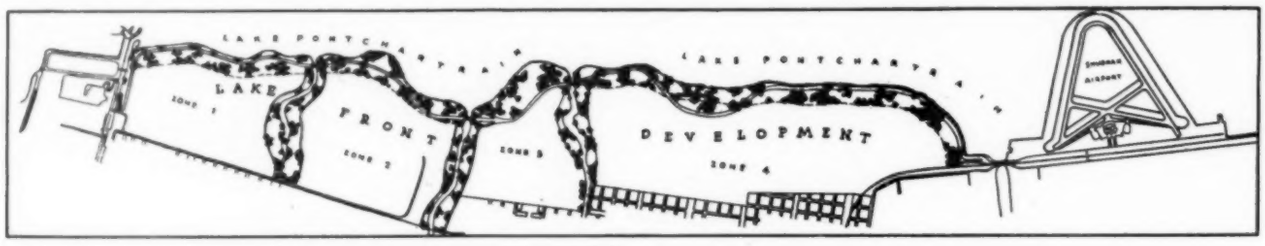
The first three photos show the roadway approximately 15 ft. wide afforded by the old bridge and the condition of the structure underneath. In photo four assembly of the new waterway has been begun, and photo five shows the removal of the old bridge by the steam shovel. Puddling was resorted to as shown in the sixth picture, to stabilize the fill around the pipe. Photo seven is a view of the inlet end; and the last picture shows the wide, safe roadway provided. The clearance is approximately 25 ft.

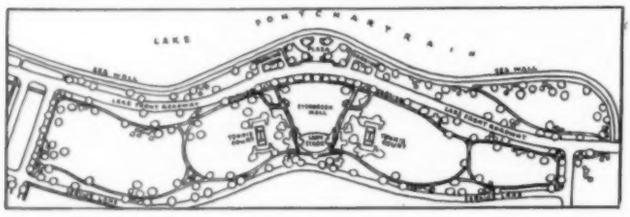


The Various Stages in the Replacement of a 15 *Ft. Wide Bridge So as to Furnish a* 25 *Ft. Roadway. The View at the Upper Left Shows the Old* 15 *Ft. Wide Structure. The Next Two Illustrations Are Views of the All Wooden Bridge. The Bottom Illustration at the Left Shows the Assembly of Pipe for the New Waterway. The Upper View at the Right Shows the Old Bridge Being Removed by a Power Shovel. The Fill Around the Pipe was Stabilized by Puddling as Shown in the Next Illustration. The Last Two Illustrations Show the Inlet End of the Waterway and the* 25 *Ft. Roadway Provided by the Installation*

New Orleans Proceeds With Important Transportation Development

"IMAGINE the greatest airport you can imagine, multiply that by ten—and you have Shushan Airport." Thus Arthur Brisbane describes New Orleans' Airport at Lake Pontchartrain. So, too, the municipal development of the lake front, terminating at the Shushan Airport, taxes the imagination. With this development New Orleans ranks among the leaders in comprehensive city improvements—the most important part of which is adequate facilities for motor traffic.





General Plan of the Lake Pontchartrain Development and Details of One Section

The New Street and Boulevard Improvements.—New Orleans recognizes the value of modern facilities for motor traffic—appreciates the importance of providing motor facilities now.

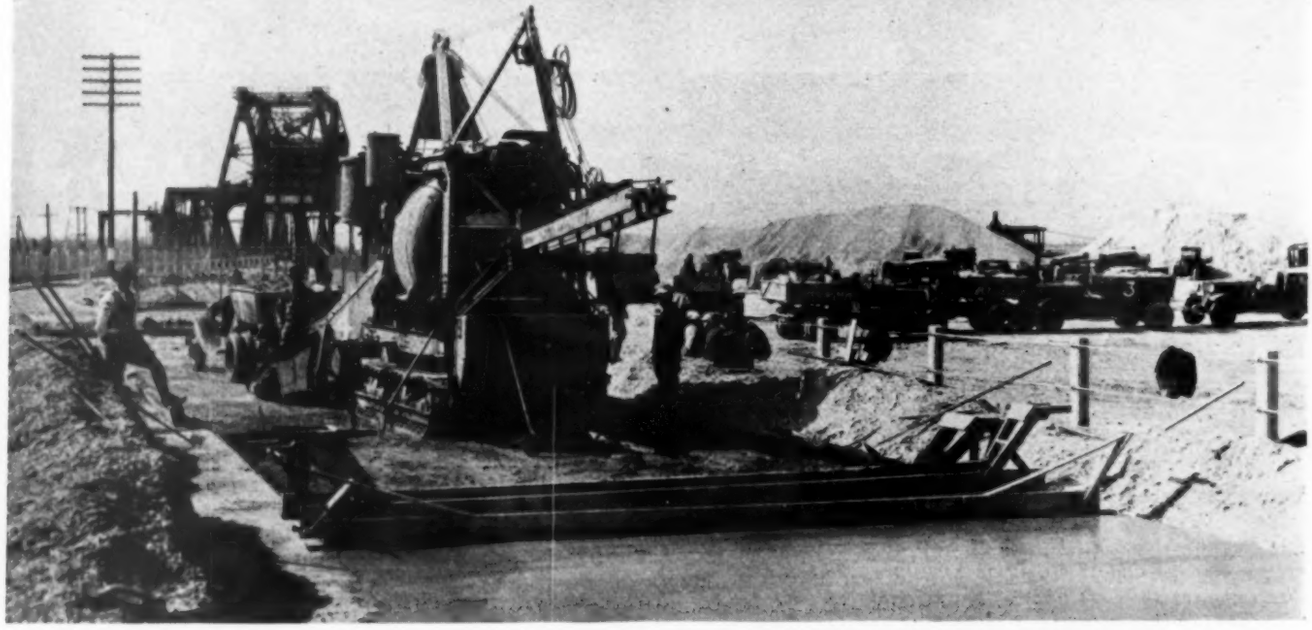
Many other cities have needs equal to or greater than those of New Orleans. Many would find it no more difficult to carry out such a plan than has New Orleans. Some states, by distributing a portion of gas tax revenues to towns and cities, have brought improvements of this character near realization. But to enjoy these benefits cities must prevent attempts to divert such revenues—attempts which are becoming increasingly threatening.

The main boulevard in the present improvement will deliver all transcontinental traffic into the city over a new and commodious route, serving as a connecting link between U. S. 90 and U. S. 51. It extends a distance of 30,600 lin. ft. from Shushan, a 4-lane, 40-ft. boulevard. This calls for a total of 136,000 sq. yd. of 20-ft. concrete. An 8:6:8-in. section is being built.

Additional paving included in the present project includes award of six concrete approaches to paved city street areas as follows: New Basin Canal; Canal Boulevard extension; Orleans Canal (two sides); Elysian Fields Boulevard; and Franklin Avenue extension.

Paving of these six city street extensions to connect with the new seawall boulevard adds 32,450 lin. ft. of 28 to 40-ft. streets, 104,500 sq. yd. of street extensions, or a total of 240,500 sq. yd. of new boulevard and street extensions.

All this is part of a $20,000,000 lake front development and beautification project, now half completed. Completion of the program will transform five miles of Lake Pontchartrain's shore line into an area of flowers



Many Trucks Were Needed to Get Material to This Pontchartrain Lake Front Paving Job

As Many as Six Mixers Were on the Job at One Time

and trees and colorful shrubbery. It will offer the city recreational facilities, and a limited number of estates for those able to pay for them.

In the past this area has been marshy—not open to utilization of any description, save for the trapping of muskrats and the location of fishermen's huts along the water's edge.

The airport is a sand fill, extending about one mile into the lake and covering approximately 315 acres. Runways are each paved 100 ft. wide, and laid out in accordance with prevailing winds of the locality. Planes may land or take off in any one of eight different directions.

Two outside runways are nearly one mile long. Diagonal runways are over 3,000 ft. long. At the eastern end a ramp is provided on which seaplanes, alighting in the water, taxi onto the platform and thence on cradles, to the main waiting rooms, just as the land planes do.

Seawall and Promenade.—To eliminate the marsh it was necessary to build a seawall the entire length of the project (approximately five miles), the cost of which has been given at $2,282,000. In addition, 33,100,000 cu. yd. of fill was required, one-seventh the yardage excavated in building the Panama Canal. Total cost of seawall and filling is reported as $8,296,000.

The seawall is flanked the entire length by a 15 ft. 5-in. 2-course reinforced concrete promenade. The slab is tied into the seawall to prevent wavewash or soil erosion in case of storm, and also serve as a curb for sections of the seawall boulevard. Drainage is obtained with 34,000 lin. ft. of 12 to 36 in. concrete pipe. For beautification, 15,000 trees and many thousand plants will be planted.

Constructing the 15 Ft. Promenade That Flanks the Seawall

Work which has been carried out during the past winter, the drainage system and paving, was made possible by a CWA allotment of $1,455,000. The grant was approved late in November. Work began Dec. 4. More than 4,000 workers were employed the first day. By Jan. 1, 5,353 men were rapidly whipping the area in shape. Of the men employed, 971 were skilled workers. These men were paid a minimum wage of $1.00 per hour. Unskilled labor was paid $12.00 for a 30 hr. week.

Six Pavers Speed the Work.—Paving began Jan. 8. On January 15, five pavers were started. On Jan. 22, when the accompanying views were taken, six mixers were running almost tandem. Excellent results are now being obtained on this work.

Application for additional funds was made soon after the present project got under way to cover development in Zone 2, shown in an accompanying illustration. Work will be carried to completion as rapidly as funds are made available.

The entire development was initiated by the Orleans Levee Board. Engineering features of the airport project are under the supervision of John Korer, chief engineer, Orleans Levee Board. Paving has been turned over to the Louisiana Highway Commission, whose engineers direct supervision of the work.

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Short Course in Highway Engineering—The 10th annual short course in highway engineering will be held at College Station, Texas, April 12, 13 and 14. The course will be under the direction of Texas A. & M. College and in cooperation with the State Highway Department of Texas.

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Motor Vehicle Tax Diversion in New York.—In 1932 $41,475,231 of special motor vehicle tax revenues in New York state were diverted to other than road purposes, including unemployment relief. Total motor vehicle taxes collected amounted to $80,390,257.

How National Planning Can Help in the Development of Major Highway System

By E. W. James

Chief, Division of Highway Transport, U. S. Bureau of Public Roads, Washington, D. C.

IF no thought were being given to the subject of administrative and economic planning, a discussion of the subject before us would be academic and more or less futile. But, it seems that the time has come when the increasing complexities of human relations do not admit of such opportunist treatment as they have received customarily now for not only generations but centuries. This fact we are not here to discuss; we accept it as a present condition, not as a theory. As the result of any scheme at national planning broad enough to include the major two items of public expenditure, highway construction will certainly be comprehended. Just how it is likely to be affected depends upon many things, and a free exploration of the possibilities would go far beyond the scope of this paper. It will be interesting, however, to consider one phase of the matter—that involving the general plan of a highway system.

We must first determine the scope of our national planning. What have we in mind at this particular time? How far do we expect to inject deliberate, preliminary planning into our scheme of government administration? Then, we might go further and consider how far national planning might be carried, continuing to have beneficial results on our road system and its administration.

To answer our first query is exceedingly difficult. Undoubtedly, we are today experimenting, and testing certain lines of direction for our future governmental operations. It is quite impossible to fix any definite limit, for such will depend upon the effects and the success of our trials in various directions. But we may discuss the several ventures now in hand and consider their effects on the national highway system.

At the present time there are more or less closely identified with the concept of national planning the follow enterprises and undertakings:

1. Balancing budgets, national, state and local. This undertaking needs no illustration.
2. Limiting the use of land. This is the idea back of the Agricultural Adjustment Administration and may, as we shall see, have considerable effect on the highway system.
3. Intensive regional development such as that contemplated under the Tennessee Valley Authority, and possibly other enterprises of a similar type.
4. Agricultural-industrial combination centers which are exemplified by the Subsistence Homestead plans.

We might select from present national operations other concepts of interest and relative importance, but aside from merely intensified measures to enliven industry and create consumers' demand, these four seem to be outstanding items in our present efforts toward definite planning.

Balancing Budgets.—The balancing of budgets presents the possibility of conditions intimately affecting our major road planning. There are two general methods of balancing budgets. One consists in estimating all items of income, pooling the proceeds and appropriating definite sums for specific purposes. Errors in the estimates for the several items are likely to offset each other at least in part and the probable error in the total is thereby reduced, thus assuring within the limits of the balanced errors that there will be sufficient funds to carry out the appropriation program. The other method is to assign to certain general projects, such as education, public works, government, and public services and benefits the proceeds of certain definite taxes. Each tax item is estimated and errors do not offset each other. There might conceivably be a deficit in the funds for the educational program, and a surplus in those for public works. We need not discuss the relative merits of the two budgetary systems. Today our administrative governmental units are using both methods usually in combination. We are interested in the fact common to both, that funds for road construction, betterment and maintenance will be definitely known in advance and highway operations must proceed at a pace strictly in accord with the available funds.

Heretofore, we have established a national system of highways with a view to supplying demands which had already accumulated. We had a legacy from the past to meet as rapidly as funds permitted. There was slight chance of making serious mistakes.

The Federal-aid Highway Act of 1921 made provision for laying out a correlated system of highways within and throughout the United States, which should comprise not to exceed 7 per cent of the total mileage of public roads in each state. Seven per cent seems to have been hit upon by those interested in drafting the legislation, because it served to provide in those states having the least total mileage of public roads (such as Nevada and Arizona) a sufficient mileage in the system to permit laying out a road across the state in two general directions, north and south, and east and west.

Mileages approved for construction with federal-aid funds under this law from 1922 to 1933, inclusive, are shown in the following table:

Year	Miles
1922	33,359
1923	168,618
1924	174,689
1925	179,680
1926	184,161
1927	187,034
1928	188,016
1929	189,851
1930	193,652
1931	198,968
1932	205,025
1933	207,194

During the first year of this federal-aid improvement program, it was relatively simple to select in most states practically all of this limited mileage by studying the distribution of population in urban centers and the total tonnage of agricultural produce by counties. These data indicated the points which should preferably be joined and the importance of the territory intervening.

No thought was given or needed to be given under the circumstances, to the rapidity of construction. Except on the state systems in a few states, there was a relatively small mileage of connected highway in the United States. The growing demands of the motoring public and the need for the improved roads which generally existed made it unlikely in the early years of construc-

tion that any serious error would be made in selecting road projects. The funds to be provided each year were never known in advance, and the program proceeded entirely on the basis of funds made available in the several states.

From the start, an effort was made so to correlate construction that the economically most advanced areas should be first recognized, and, so far as possible, continuous and connected routes should be improved.

Under a definite budgetary policy with funds fixed each year and the amount available known in advance, we shall have to plan construction programs more carefully with due regard to the requirements of the whole national plan.

Limiting the Use of Land.—That plan is going to include a limitation in the use of land in certain less desirable areas, and, in contrast, the intensive development by either regional or more localized planning in other areas.

Obviously, the limitation on the use of land will lessen the necessity for highway extension wherever such limitation is effective, and there will arise an increased necessity for highway extension and improvement in regions placed under intensive use.

The watershed of the Tennessee River comprises parts of the states of Kentucky, Virginia, Tennessee, North Carolina, Mississippi, Alabama, and Georgia. The federal-aid system in these states amounts to 0.089 mile per square mile. The area of the watershed according to the Tennessee Valley Authority is 40,740 square miles, and the federal-aid system in the area provides 0.094 mile per square mile. The road development now projected, as exemplified in the federal-aid system, is, therefore, practically the same over the whole area and over the Tennessee watershed. It is patent that an intensified development in the Tennessee Valley and a possible abandonment of lands elsewhere in the states involved will require a change in this relationship. This is a case where planning is probably going to compel a change in our previous schemes. New economic demands may be expected where they were previously absent, and these demands will constitute a first call on whatever work the highway budget permits.

Effects of Intensive Regional Development.—Exactly the same reasoning leads to the conclusion that in smaller areas placed under intensive planning, as in the case of subsistence homesteads, there will be an increased urge toward the higher improvement of local roads. These smaller areas will constitute communities of importance when compared with the general countryside, and it will probably be necessary to bring main roads to a suitable contact with these communities. This condition indicates certain definitely required road work growing out of an element in the national planning scheme that the highway engineer will not control. Some other agency will be handling the development of the large valley region, and still another agency will be in control of the local community developments. The highway engineer is going to find himself obligated to conform his program, within the limits of his budget, to the fixed and known requirements of other features of the national planning scheme.

The conclusion of this seems clear. If intensification of use in one area creates new demands there, and less use elsewhere diminishes the need for road work; if the creation of new communities sets up new demands, the highway administration will have to become more centralized and its relations with the rest of government administrative agencies more closely correlated than heretofore.

Such developments as those referred to above will necessitate unquestionably additions to the primary road system, and probably will make very substantial changes in the importance of feeder roads in certain areas. The definite selection and the development of hydroelectric power sites and the location of industrial centers with their tributary subsistence homestead areas may alter the entire highway pattern of a large community. These alterations will have to be recognized immediately by the highway engineer in his annual roadbuilding program, and with definitely limited funds will undoubtedly result in quite a different concentration of expenditure than that which has been followed during a period of widespread highway extension.

Both the quantity of construction possible annually and its location will be much more definitely determined by elements beyond the control of the highway engineer than have existed heretofore.

Under such conditions the location and the need of certain new roads will be rather obvious; but, on the other hand, the funds available elsewhere throughout the states will be reduced and the selection of projects on which to place these funds will become correspondingly difficult and will require more careful studies of the economics involved in each project.

Areas which are taken out of cultivation will undoubtedly lose population, and there will be a corresponding decrease in the need for local road improvement. It is conceivable that large areas may be reforested, in which for many years there would be a minimum demand for local roads; but, on the other hand, there would be correspondingly intensive need for local secondary or feeder roads in the deliberately developed areas.

Some idea of the extent of the present marginal land areas may be obtained from the fact that the first surveys contemplated of such areas comprise several belts aggregating over one-quarter of a million square miles. Although it is highly improbable that all of the areas so surveyed will be rejected for purposes of cultivation, undoubtedly a very large part will be so rejected, and, in some states in the semi-arid regions, the effect on the road system will be substantial.

If any general scheme for national planning, it is probable that serious adjustments will have to be made in the levying of taxes. How far this may go cannot be foreseen. The committee on a model tax law of the National Tax Association has been working for years on its project, and so far, little impression has been made on the chaotic system of taxation prevailing throughout the United States. In many of our states there are hundreds of separate taxing authorities levying a score or more of different kinds of taxes. It is to be hoped that when national planning tackles this serious and fundamental problem, it will develop some orderly arrangement and follow some definite set of principles which will produce adequate revenue and through state and local budgets distribute that revenue as nearly in accordance with benefits received as possible. When national planning has accomplished its proper ends with respect to our tax system, there will be no longer any diversion of motor vehicle user revenues for miscellaneous purposes, and the proper share of land taxes for local road requirements will be established on a rational basis.

Correlation of All Transport Systems.—National planning will conceivably have to consider the correlation of our entire transport system, including essentially the railroads, the highways, and our inland waterways. This problem today is one of the most intricate and perplexing of any confronting us, and the financial interests involved are enormous.

It is practically impossible to determine accurately unit costs by any of these three major transportation me-

diums; but, certainly, a solution will not be reached until sufficiently accurate data are obtainable for determining under what set of conditions it is most economical to haul by highway, railroad, or water.

This problem opens a vast field for investigation, and in any adequate national planning it must be thoroughly explored if we are to develop a combination which meets the requirements of modern business on a basis which shall be the most economical possible.

Again, as a result of the tax phase and the transportation phase of national planning, I can see only a greater centralization of authority, for it is obviously impossible to handle these matters locally and have them fit snugly into any national plan.

Finally, it may become possible if our first steps in a career of planning are successful to approach the highly controversial subject of local government. A large part of our country is organized administratively on the basis of a seriously impeded transportation. Our counties were largely laid out to meet the conveniences of a period of horsedrawn traffic and now motor roads and the old county organization affect our road administration everywhere. So far as highways are concerned, this detail has already received due attention and has been the subject of positive action in some states. The success of a centralized state road administration is watched with deep interest in states like North Carolina, Virginia, Pennsylvania, and Michigan, where adjustments have been made or are in progress.

This fact again must be recognized as probably emphasizing the drift toward centralization in the road administration of the states throughout the nation.

To summarize, we may expect, I think with a reasonable assurance that a sound national planning should stabilize our road funds and probably eliminate unusual construction peaks. It will make necessary some readjustments and additions in our primary routes, and probably a very considerable change in the distribution and demand for local roads. It should, once for all, simplify and rationalize our whole system of taxation and favorably affect both local road and state road resources. And, it should allay whatever controversy exists among the proponents of the principal forms of transportation, and establish all of them on a sound, economic basis. Eventually, it will lead, without doubt, to a greater and greater degree of centralization of highway administration.

Acknowledgment.—The foregoing is a paper presented at the 20th annual Purdue Road School.

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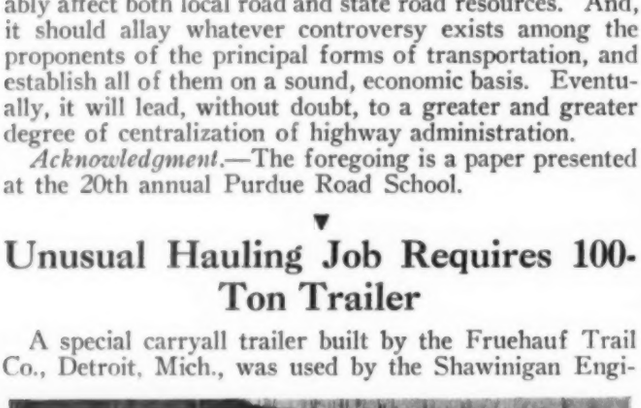
Unusual Hauling Job Requires 100-Ton Trailer

A special carryall trailer built by the Fruehauf Trail Co., Detroit, Mich., was used by the Shawinigan Engineering Co., Ltd., of Montreal, Quebec, for moving three 100-ton transformers 13 miles from a railroad to their ultimate destination. The trailer has sixteen solid rubber tired wheels in back and eight in front. A heavy I-beam steel frame strongly reinforced with cross members was used, with two steel rails for loading laid cross-wise on the trailer and welded securely into position.



100-Ton Transformer Being Moved from Railroad Car Onto Special Fruehauf Carryall Trailer

Two 5-Ton Leyland Trucks Were Used to Pull the 100-Ton Capacity Fruehauf Carryall. The Two Similar Trucks in the Rear Were Provided as a Braking Precaution Due to Steep Grades and Snowy Roads. All Four Trucks Had 6-Ton Payloads for Better Traction

Shipped one at a time, the 100-ton transformers were moved from the railroad car onto the trailer over a special section of track which had been attached to the rails on the trailer. The transfer was performed without difficulty.

Two 5-ton Leland trucks were used to pull the trailer, the tractive effort required being 20,000 lb. drawbar pull. Two trucks were also placed at the rear to act as a braking precaution due to steep grades and snowy roads. All of the trucks were loaded with 6-ton payloads of crushed stone to assure good traction.

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Mexico's Highway Program for 1934

Vice Consul William P. Cochran, Jr., Mexico City, reports in Automotive World News of Feb. 20, that the Mexican Government had announced its plans for highway improvements (except for construction of the Mexico City-Laredo Highway) during 1934 which involves an expenditure of 4,000,000 pesos providing the States spend a similar amount. For 1934, the program includes 994 miles to the graded and 869 miles to be prepared for surfacing. In 1933 the grading and embankment work on 869 miles was completed and 248 miles was prepared for surfacing. So that for the two year period 1,863 miles will have been graded and prepared and leaving 2,040 miles for improvement in subsequent years to complete the National Highways selected for improvement under the present program.

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Gas Pumps Ordered 20 Feet Back From State Roads

Gasoline pumps and other devices for servicing motor vehicles along state trunk roads outside of municipalities must be set back at least 20 feet from the edge of the highway right-of-way, according to a ruling announced by the State Highway Department of Minnesota. This order was issued as a safety measure to keep cars off the highways while being serviced. The department seeks first to prevent the erection of any new filling stations too close to the roadways, and also to obtain relief in cases where existing structures constitute a menace to safety. Authority for such action is provided in state laws.

How an Unusual Slide in a Highway Cut Was Handled

THE engineers of the Colorado State Highway Department were faced with an unusual problem when, in locating the Federal Aid Highway west of Sapinero, a cut was made which destroyed an existing irrigation ditch.

To re-establish this line of water conveyance, the first expedient resorted to was the digging of a new ditch along the side of the cut and lining it with metal flume. However, soon after water was put through the new ditch, the hillside began to slide which caused the flume to be moved laterally out of line and to spill over with a consequent increase in the amount of slippage. This finally resulted in a slide landing in the highway.

Fig. 1—View Showing Location of the Line of Pipe in the Cut.

John J. Vandemoer, Division Engineer, investigating the trouble, found that the chief difficulty was caused by the water passing over a very soluble formation of sandstone for a short distance before it entered the metal-lined portion of the ditch. This peculiar sandstone, while almost too hard to be picked when dry, dissolves like lump sugar when place in water.

Careful checking showed that the Armco flume had not leaked and that the trouble began by water entering this stratum of soluble material before it reached the flume. The ditch had not been lined for a sufficient distance to cover this entire stratum, and no watertight transition had been made between the flume and the old ditch.

The highway engineers solved this annoying problem by the installation of approximately 250 ft. of 24-in. heavy gage Hardesty welded pipe, soil-proof wrapped, in a trench cut well back into the hillside so that any rolling material would pass over it without doing damage. Rapidity of installation was important since the ditch carried water both for irrigation and for stock watering, neither of which could be delayed. Telephone calls between the engineers and the manufacturer at Denver who supplied the pipe, brought about prompt delivery. The Dayton couplings employed were shipped by express from the East on telegraphic order and arrived about the same time as the pipe which had been hauled from Denver by the contractor's trucks.

Installation was accomplished without difficulty and the couplings allowed sufficient flexibility of the joints to conform to the slight bends necessary.

The accompanying illustration, Fig. 1, shows the location of the line of pipe in the cut and Fig. 2 is a view of the pipe on the site.

The old flume was utilized to aid still further in preventing a recurrence of the slide difficulty by installing it as ditch lining at the outlet end of the pipe as shown

Fig. 2—Pipe on the Site of the Job.

Fig. 3—Old Flume Was Utilized as Ditch Lining at Outlet End of Pipe.

in Fig. 3. Note the concrete transition which is similar to the one at the inlet end of the line.

This installation has now been serving about four years without any attention and with every indication that no more trouble will be experienced.

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Traffic Accidents in Night Driving

Data on the number of traffic accidents occurring at night mean very little unless the amount of travel during that time is known. Some interesting information on this subject is given in a paper presented last winter before the Boston Society of Civil Engineers by Clarence P. Taylor, Traffic Engineer, Massachusetts State Highway Department. Mr. Taylor in his paper stated:

"Based on actual traffic counts of vehicle movements over all parts of the state, it is found that 23 per cent of the annual volume of vehicular traffic throughout the state highway system moves during hours of darkness. In the three-year study, 42 per cent of all the accidents occurred after darkness. This should be expected, for it is common knowledge that the human eye cannot see as well in darkness as in daylight."

"It might be interesting to compare accidents in which pedestrians or obstructions are struck with the other forms of collision. These data are shown on Table II and indicate that a little less than 7 per cent of all accidents occur to pedestrians during hours of darkness. Collisions with obstructions in the road are an insignificant part of the total. These figures indicate that in all likelihood moving objects are more difficult to see than are those which are more or less stationary. The bulk (76 per cent) of the pedestrians who are struck after dark happens to be somewhere between intersections rather than at intersections. The same holds practically true for all other types of accidents. The problem of accidents after dark primarily is that between intersections rather than at intersections, although caution should be observed in this respect, since it was pointed out before that the intersection is the point along the highway at which the greatest concentration of accidents occurs."

TABLE I.—RELATION OF DARKNESS AND ACCIDENTS

Type of Accidents	Accidents Occurring During Darkness		
	Total Number	Number per Mile	Per Cent of All Accidents
Pedestrian	849	.51	6.68
Obstruction in road...	28	.02	.22
All others.....	4,468	2.68	35.17
Total	5,345	3.21	42.07

TABLE II.—RELATION OF DARKNESS AND ACCIDENTS—*Concluded*

Location	Distribution of Accidents in Darkness			
	Pedestrian		All Others	
	Number	Per Cent	Number	Per Cent
At intersections.....	203	24	1,260	28
Between intersections.....	646	76	3,236	72
Total	849	100	4,496	100

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Highway Traffic Speeds

During the summer of 1933 the Maryland State Roads Commission carried on a highway traffic speed survey to obtain comprehensive knowledge of the way traffic actually uses the state highways. The speed of traffic was observed at about 50 of the regular traffic census stations which the State Roads Commission has used for many years. The results of the survey were reported by Dean A. N. Johnson of the University of Maryland at the 13th annual meeting of the Highway Research Board. The following summary of his paper is given in Highway Research Abstracts.

At each point two observers counted and measured the speed of traffic from 9 a. m. until 4 p. m. One observer counted the traffic, dividing it as to direction, while the other noted the speed of traffic. This was done by the use of the Eno Foundation speed detector as devised by Professor C. J. Tilden of Yale University. It is an extremely simple and ingenious device, consisting essentially of a square box with two sides removed and a mirror placed on a diagonal plane. Thus, when a vehicle goes by the box its reflection is flashed to an observer at a measured distance down the road. About 500 vehicles were timed in each direction at each station.

The average speed as observed from 41,000 vehicles was 35.5 miles per hour, with 87 per cent of all the traffic within 45 miles per hour and 99 per cent within 55 miles per hour and only an occasional vehicle moving over 65 miles per hour.

The percentage of various rate of speeds is shown in the following table:

8	per	cent	between	15-25	miles	per	hour.
36	"	"	"	25-35	"	"	"
43	"	"	"	35-45	"	"	"
12	"	"	"	45-55	"	"	"
1	"	"	"	55-65	"	"	"

Resurfacing Old Concrete at Champaign, Ill.

An excellent example of resurfacing and widening an old concrete pavement with concrete is the work completed relate in 1933 on Neil St. between John and Charles Sts. in Champaign, Ill.

Dowel Bars Lap the Point Where Widening Starts

This section is part of U. S. 45 and I. S. B. R. 25, carrying 3,000 to 5,000 cars per day. The old surface, a 7-in. concrete street built in 1914, was 27 ft. wide. A width of 40 ft. was needed. The old pavement was built in 1914. It has required almost no maintenance. But

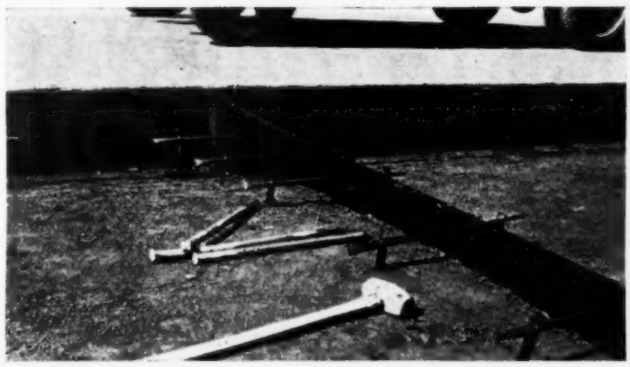
Expansion Joints Were Put at 30 ft. Centers

it was not a smooth pavement, in modern terms. Heavy traffic demanded that it be improved.

The contract price was $34,880 for resurfacing and widening covering an area of 17,053 sq. yd.

The resurfacing is 5 in. thick with a 58-lb. reinforcing

Considerable Hand Labor Was Used in Finishing



Pins Driven in Old Concrete Held Dowels and Joint Filler in Place

mesh. No effort was made to secure a bond between the two slabs. The widening strips are 8½ in. thick.

A 1:2:3½ mix, with a coarse aggregate having 2-in. maximum size, was used. Expansion joints were put at 30-ft. centers. No contraction joints were placed. These joints were held in place while concrete was being placed by pins set in holes drilled in the old pavement. This method was very satisfactory.

Contract was performed by the General Paving Co. Design and supervision were by the Illinois State Highway Department.

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Employment on Public Roads

According to the January Trend of employment bulletin of the U. S. Department of Labor 169,417 men were employed in the construction and maintenance of state and public roads in January, 1934.

Due to weather conditions there was a decrease in the number of employes working on state highways, comparing January 1934 with December 1933, of 13.8 per cent. Pay rolls for these workers also decreased 15.1 per cent. Of the workers engaged on state roads, 84.6 per cent were engaged in maintenance work and 15.4 per cent in the construction of new roads.

Table I shows the number of employes engaged in the construction and maintenance of State and Federal public roads, by months, January to December 1933.

TABLE I.—NUMBER OF EMPLOYES ENGAGED IN CONSTRUCTION AND MAINTENANCE OF PUBLIC ROADS, STATE AND FEDERAL JANUARY TO DECEMBER 1933*

Month	Number of employes working on— Federal roads	State roads New	State roads Maintenance	Total
January	74,405	39,906	150,989	190,895
February	76,969	36,352	140,639	176,991
March	95,491	37,891	145,559	183,450
April	121,089	40,560	136,996	177,556
May	138,934	47,540	142,713	190,253
June	151,614	54,388	152,855	207,243
July	128,801	61,428	141,558	202,986
August	106,907	60,365	158,159	218.524
September	79,980	62,366	160,492	222,858
October	56,872	58,711	171,260	229,971
November	38,112	63,379	170,765	234,144
December	21,345	46,810	140,813	187,623

*Excluding employment furnished by projects financed from the public works fund.

The peak of employment on Federal roads, other than those financed from the public works fund, was reached in June, when 151,614 people were working under the regular Federal highway appropriation. The high point in number of employes working on state roads was reached in November, when 234,144 employes were paid from state highway funds.

EDITORIALS

The Effects of Currency Inflation

WILL prices rise if our currency becomes inflated? The inflation of our currency is likely to have a profound effect upon the cost of producing and marketing all goods. Under the law the President was authorized to reduce the gold dollar to half its present weight and to "confiscate" half the gold in the banks, paying for that gold with "gold certificates." The President may use this "confiscated" gold as a basis for the issuance of paper money and thus would inflate the currency. By this process, he and the banks would be able to double the present currency. In view of the program of enormous federal expenditures for public works, unemployment relief, etc., it is highly probable that the present currency will be increased within a year or two. What will be the effect on commodity prices and wages?

The economists who are advising the President believe that prices and wages will rise as a result of the currency inflation. Many—perhaps most—of the professors of economics agree with them. But not a few argue that, because "credit currency" (bank checking-deposits) far exceeds money, a doubling of the money will not raise prices or wages greatly. Fortunately for the business man who is not well versed in political economic theories, it is possible to hark back to some facts that are very illuminating.

During the years 1914 to 1918, European nations paid Americans vast sums of gold for food, guns and ammunition. Upon that gold as a basis paper money was issued. Hence, shortly after the war ended, America had increased its per capita money stock about 90 per cent. Concurrently wages and average commodity prices rose more than 90 per cent above the levels of 1914. Then in the spring of 1920 the boom collapsed and most prophets foretold a speedy return to the wage and price levels of 1914, but no such thing happened. From 1922 to 1929 average wholesale commodity prices were quite steady and averaged nearly 60 per cent above the level of 1914, and average wages were more than double those in 1914.

Much the same thing happened during and following our civil war which started in 1861. Our currency was increased about 50 per cent during that war and prices and wages increased a much greater percentage, and for years after the slump in 1865 they remained 40 per cent above the level of 1861.

Every great modern war has been accompanied by currency inflation, and that inflation has been followed by price and wage rises. It has been argued that such rises were always due to fear that the currency would ultimately become worthless, but no such fear existed afer our Civil War ended, and it did not exist as to American currency either during or after the World War.

Significant as such facts are, much more significance attaches to a fact that is not widely known; namely, that during the years 1839 to 1929, in America, average wages increased almost exactly in proportion to the increase in the per capita stock of money, whereas per capita bank deposits increased at a vastly greater rate. Between 1879 and 1929 our per capita stock of money became three-fold and our per capita bank checking-deposits became ten-fold. If average wages had been controlled by bank checking-deposits ("credit currency"), then wage rates would have become ten-fold during those 50 years; but, as a matter of fact, they became three-fold thus showing their close relationship to per capita money and not to checking deposits.

Of course both wages and commodity prices rise in good times and fall in bad times, temporarily seeming to be uninfluenced by per capita money. But, in the course of a little time, per capita money and average wages get in step and again march together. Hence it is a safe bet that, if the President doubles the present per capita currency and keeps it doubled, the ultimate effect will be to double the wages that existed in 1929, which means tripling present annual wage rates. Remember that right now per capita money is not greatly different from what it was in 1929, so that the prospective currency inflation rests upon a currency that is already inflated.

As wages rise so will average commodity prices during the next few years. Hence average commodity prices will probably become about double what they were in 1929, or three times what they now are—provided that the President doubles our present volume of currency and takes no subsequent steps to decrease that inflation. Of course he plans deflation if inflation raises average commodity prices above the 1929 level. But to effect deflation, bonds will have to be authorized and sold in order to withdraw currency from circulation. Will Congress authorize large bond issues, says of $9,000,000,000, to effect currency deflation back to the present level? *No legislative body in the history of the world has ever deflated an inflated currency, for to do so would involve a great and unpopular increase in taxation.*

Our advice is to "watch your step" as to long-time contracts, if the President inflates the currency greatly. Buy, but do not sell, commodities on long-time contracts.

The accompanying table tells a story the import of which is inescapable.

TABLE SHOWING THAT THE AVERAGE ANNUAL WAGE AND PER CAPITA MONEY HAVE THE SAME TREND*

Year	Annual Wage	Money
1839	$236	$11
1849	248	12
1959	289	14
1869	378	23
1879	347	24
1889	484	26
1899	469	29
1909	590	38
1914	680	39
1919	1,278	73
1929	1,491	70

*The annual wage is the average of wages and salaries in manufacturing industries, as deducted from the U. S. Census, except for the year 1839 when census statistics were not taken. The per capita money is the total money at the middle of the year, divided by the total population. The average annual wage tends to become about 18 times the per capita money, the departure from this ratio being small except in hard times.

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W. P. Gillette

County and Township Roads

A Section Devoted to the Interests of Those Responsible for Secondary Road Improvement

Preparation Work for Bituminous Mulch Treatment

EXPERIENCES in the preparation of roads for a bituminous surface were described by J. Ray Stout, Surveyor of Union County, Indiana, in a paper presented at the 20th Annual Purdue Road School. The work was done last summer and involved three different roads. The problem on each was to provide adequate drainage, shoulders of proper alignment, and a hard, smooth road surface of proper cross-section. Each road required slightly different preparations to meet these requirements and consequently the unit costs varied. The matter following is quoted from Mr. Stout's paper:

The first road prepared was the Velocipede Pike, running due west out of College Corner. The work consisted of widening culverts and installing new ones where needed, cutting and grubbing bushes and trees along the right of way, side ditching, and widening shoulders. The greatest item of expense in this work was due to the widening of shoulders. In this construction, the sod was worked to the outer edge to stabilize the fill and to prevent erosion.

The shaping of the road consisted of grading down a portion of the crown and blading the loose material toward the edges of the roadway. This thickened and stabilized the outer edge and improved the riding qualities. Thus, the traffic was inclined to make use of the entire roadway, packing the loose material very rapidly. Care was taken at all times not to cut through the surfacing material and impair the base in any way. The stone which interfered with this work was taken out by hand labor.

We moved next to the College Corner and Richmond Pike, lying in the eastern part of the county and connecting State Road No. 21 with State Road No. 27. This road had fairly good drainage. Other than installing a few new culverts and widening the existing ones, we devoted most of our time to the grading and shaping of the road bed. Besides being rough, due to the number of large stones in the base, it had the unique feature of having a grade or rise of about 4 to 7 in. in 40 ft. and a fall of the same amount in the next 40 ft., a feature which prevailed with surprising regularity the entire length of the road. This waviness was very noticeable to motorists. As correction of this feature would require considerable disturbance of the road bed, we were faced with a rather serious problem, due to the short period of time available for the disturbed road bed to again stabilize and attain the hard and compact surface desired as a base for the bituminous top to be applied four or five months later.

We proceeded with the work by marking the high and low sections of the roadway, then setting the grader blade at right angles to the center line of the road and cutting heavily on the high sections and depositing the loose material in the depressions. This process was continued until the road bed was comparatively smooth and level, and the cross section had reached the shape desired. The elements were in our favor during this work as it rained just enough to keep the road slightly softened, a condition that was necessary to accomplish the work in the most satisfactory manner. The stone which interfered with blading was picked loose by hand labor and all oversize stone was raked into piles and hauled away by truck.

During the month of September, three miles of the Billingsville Road were put into condition for black-topping in 1934. This work consisted of widening, side ditching, and construction of shoulders. During the work of preparation for the bituminous surface, shoulders of about 4-ft. width were supplied with ½ in. to 1-ft. slope. The bottom of the side ditches were cut not less than 2 ft. below the crown of the roadway, with special attention given to the grade in order to be sure of adequate drainage. The road was crowned to a slope of about ¼ in. to 1 ft. and a width of 18 ft.

Tar was the bituminous material used in the treatment. Washed gravel was specified with 95 to 100 per cent passing a 1-in. round screen, 35 to 70 per cent passing a ½-in. screen, and 0 to 5 per cent passing a ¼-in. screen. We required that 35 to 40 per cent of the material be crushed.

Costs.—The cost per mile of preparation for a bituminous surface will vary according to the amount of work to be done and the methods used. A check-up on our county trucks with three men per truck hauling earth for shoulders and embankments, an average distance of ½ mile, showed an expense of 35 ct. to 40 ct. per cubic yard of earth moved, depending on the conditions.

By using a tractor and a two-wheeled "maney" scraper in connection with our earth moving activities, we were able to cut down our expense and speed up the work. In side ditching and construction of shoulders, we marked the sections where it was desirable to use the wheel-scraper and left the rest to hand labor. As a result, in most cases the bulk of the earth was handled by equipment. The main factor governing the use of the wheel-scraper is the distance necessary to move the earth. We consider 600 ft. the maximum distance practicable to haul. On a number of our county roads where the shoulders are too high and an excess of earth exists, the surplus can usually be used to advantage for widening embankments and shoulders within a haul of 600 ft.

On a section of road with high shoulders and no side ditches, we proceeded by cutting down the shoulders to a depth of 6 or 8 in. below the desired finished surface, then cut the side ditches with the grader and turned the loose material over into the shoulder depression. An experienced grader operator can judge with reasonable accuracy the amount of material to be taken out of the shoulder to make room for that which comes from the side ditch. This method eliminates hand labor and the use of trucks to haul material.

The number of yards moved per hour by this method

will depend upon the class of material to be moved and the distance hauled. Where no difficulty is experienced in scooping and a tractor is used with a speed of 6½ miles per hour on an average haul of 300 ft., twenty trips per hour can be made with ample time to turn and load.

Cost per cubic yard of moving earth by this method can be figured in the following manner:

	Per Hour
Two men at 30 ct.	$0.60
Gas at 15 ct.	0.375
Depreciation and up-keep	0.30
Total	$1.275

Twenty trips with a 1¼-yd. wheel-scraper will move 25 cu. yd. of material for about 5 ct. per cubic yard. This is an economical method up to 15 ct. per cubic yard.

In this work of preparation of the road bed, there are three important items to be taken into consideration in securing a successful bituminous surface; namely, adequate drainage, ample shoulders, and a hard, smooth riding surface of the proper cross section. Good roads depend not only upon good engineering principles and theories, but upon their best application with the equipment and funds that are available.

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*Tightening Up On Specifications**

By EARL MINGS

Surveyor of Shelby County, Indiana

SPECIFICATIONS should be so worded by using plain English and simple words and having complete sentences coherently arranged that most any ordinary person can thoroughly understand the meaning.

The specifications should be in harmony with the job or work to be done and the plans thereof. Set aside the different classes of work and specify separately just how this work is to be carried on, how it is to be finished, how it should look when completed, and emphasize the quality of materials and workmanship according to their classifications. When specifications are made up in this way, they will not cause an unnecessary expenditure of money on a project. A very elaborate project will require an elaborate set of specifications; very plain or ordinary type of project will require a very ordinary set of specifications. You may have a very complete and elaborate set of plans for a project, but with a very loose or incomplete set of specifications, and when the project is completed, you may have something on your hands or hanging over your head that you are not at all proud of and are really afraid of.

On the other hand, you may have a very poorly designed set of plans for a project accompanied by an excellent set of specifications (tight specifications) which with first class materials, workmanship, and engineering will result in a completed project which may not excite pride for its architectural design but at least it will withstand the usage for which it was intended and not become a hazard to life or to other property. Therefore, I contend that good specifications are far more important than good plans for any project.

We engineers having charge of work being carried on in our respective counties are apt to come into direct contact with all types of contractors. Some have the best of intentions and other have intentions not so good. Because of this last type of contractor, specifications sometimes have to be made very tight. Therefore, if any of the intentions happen to be omitted in the make-up of the specifications, these so-called smooth contractors are apt to find a loop-hole and in most cases will take every advantage of this opportunity regardless of how fair the supervising engineer is trying to be. Therefore, both types of contractors have to read the same kind of specifications. The engineer should use every precaution in writing specifications to protect life, property, and money, and also to protect himself.

In writing this type of specifications it is very essential to clearly insert all of the things that you intend for the successful contractor to perform, stating clearly the quality of the materials, the type of equipment needed, the quality of the workmanship, the number of men and the qualifications of these men if any are required on certain equipment, the time of starting the project, the time of completion, allowing for any reasonable, necessary, or unavoidable delay that might occur in obtaining the specified kinds of materials or that might occur from bad weather conditions or from any circumstances beyond the control of the contractor or the engineer. State clearly how the contractor is to be paid, what services he is to pay for and how and when he is to pay them, and under whose inspection the work is to be performed.

In conclusion, it is my opinion that tightening up on specifications and making clear, clean-cut specifications is equally essential to the contractor, to the supervising engineer, and to the people whose money is involved or whose life depends on the quality of construction.

This type of specification makes it easier for the contractor to make an intelligent proposal. It protects him, makes him feel that he is dealing with a fair-minded person, and that he is not wasting his good time in making up his proposal only to be excluded when the bids are opened, as he might be if he were bidding from an inferior set of specifications that could be variously interpreted as the contractor sees fit. It is my belief that if specifications were gotten up along these or similar lines, it would ease the minds of those responsible for letting contracts, providing the low bidder accompanies his bid with a suitable bond. Because, if the contractor for any reason did not prove satisfactory, his bondsman would have to carry out the intent of the contract.

*Paper presented at Twentieth Annual Purdue Road School, January 22-26, 1934.

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Photographic Method of Studying Traffic

A new method of securing accurate data on traffic behavior by means or pictures was described by Professor Bruce D. Greenshields of Denison University in a report presented at the 13th annual meeting of the Highway Research Board. The report also explained the use of such data in the development of a new formula for expressing the relation between the number of vehicles passing a given point, their average speed, and spacing. From the position of a vehicle in two or more pictures taken at short definite intervals of time its velocity and acceleration can be determined. A 16-minute Simplex moving picture was geared for a constant time interval between exposures. From 6,000 pictures of 794 vehicles the following expression for the spacing of cars whose speed is controlled by that of the leading car of a group was developed.

$S = 21 + 1.1\ V$, wherein S is the distance c. to c. in feet between the vehicles and V is the velocity in miles per hour.

Patrol Maintenance on County Roads in Ontario, Canada

By J. G. CAMERON

County Engineer, United Counties of Stormont, Dundas and Glengarry, Cornwall, Ont.

IN dealing with the subject "Patrol Maintenance" I shall first endeavor to recall a few general facts, and follow this up with a description of the system in operation on the county roads in the united counties of Stormont, Dundas and Glengarry.

The first duty of Road Superintendent.—We all realize the necessity of maintaining in a state of repair any article produced by man, if man intends to continue using that article. Many theories have been expounded regarding the economics of road construction and maintenance. A poor man can not always afford to be economical, and the same applies to a municipality. The word "Patrol" is a military word and implies that someone is always on guard. Military leaders realized that an army could not be kept intact without being properly guarded at all times.

Road builders and those responsible for road building have often been guilty of creating expensive systems of roads and leaving them unguarded. It matters not whether a road costs $1,000 per mile and carries 100 vehicles a day, or whether it costs $30,000 per mile and carries 3,000 vehicles per day, it is obvious that someone should see to it that the natural enemies are prevented from destroying it. If a crack appears in a concrete pavement, it should be filled; if a gravel road ruts badly, it should be dragged; if a surface break occurs in a bituminous road, it should be patched before the natural enemy gains a foothold. A stitch in time saves nine.

It appears then that the first care of every road superintendent should be a properly-organized patrol system. It would appear to be folly on the part of anyone to say in a general way that a certain type of patrol organization is the most efficient. To approach the best system in any particular locality, one would have to study local conditions as regards traffic, local materials available, social status of the community, etc.

Our county road system consists of 331 miles of road, with surface widths varying from 10 to 18 ft. There are about 200 miles of bituminous surfaced and 131 miles of traffic-bound gravel and crushed stone roads. The area served is 60 miles long by 25 miles wide, with a population of 70,000 people, fairly uniformly distributed in towns, villages, hamlets and on farms. The road system connects all these centres of population in checkerboard fashion with the township roads as feeders, and the King's Highways carrying the foreign through-traffic. Traffic census shows a daily summer average of from 200 to 800 vehicles.

The land in this section of the St. Lawrence and Ottawa valleys consists chiefly of clay flats and hard pan knolls, with an occasional gravel hill or limestone outcrop. Our road material consists chiefly of a poor grade of gravel, field stone and limestone from quarries, and this material is fairly equitably distributed.

The Patrol Organization.—Our patrol organization consists of a general foreman, mechanic, six patrolmen, six patrol assistants, two power-grader operators, and two extra truck drivers. Aggregate used in the work is supplied by three crushing plants and from pits. Equipment consists of a centrally-located general repair shop, eight trucks, two power graders and all necessary small tools.

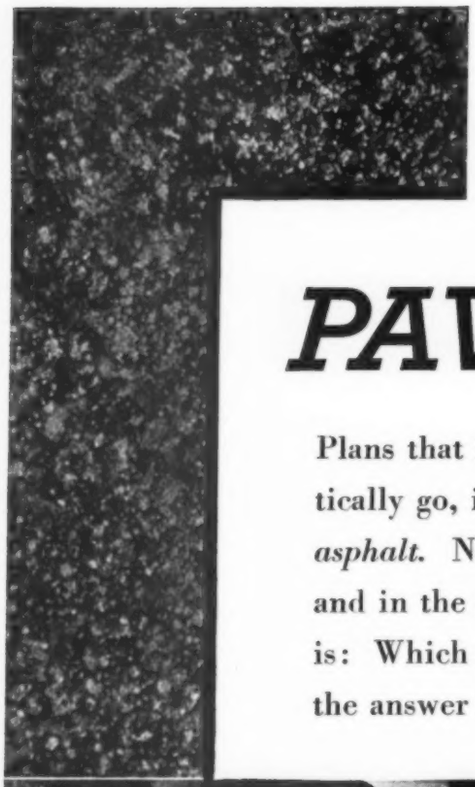
The area is divided into six patrol districts each with about 60 miles of road. The patrolmen are so located that none of their roads are more than 15 miles from their home, with most of the main roads in their districts within five miles. No patrolman is more than 25 miles from the central repair shop and four of them average 12 miles distant.

Each patrolman has absolute charge of maintenance work in his district and is responsible only to the general foreman who reports to my office. Each of these men is supplied with a truck and outfit of small tools. He receives 10 cents an hour more than ordinary labor, and is also allowed one hour each day more than ordinary labor to service his truck and take the men to and from the work in hand. His assistant is a man capable of operating the truck and supervising small jobs, and is paid 5 cents an hour more than common labor. The patrolman has authority to hire extra men, trucks or teams when required, and for ordinary work in the Summer a gang consists of a patrolman, helper and two or three extra men.

Power-maintainer operators have definite traffic-bound roads to grade in two or three patrol districts and report to the general foreman, but are subject to instruction from the patrolman in whose district they happen to be working. The two extra trucks, one with dump body, and one with commercial body and spray pump, work out from the general shop under direction of the general foreman, and receive instructions from the patrolman in whose district they happen to be working. All trucks are taken to the central shop for major repairs, and to be checked over occasionally on rainy days. The work of both power maintainers brings them close to the shop about once a month, when they are checked over by the mechanic. All equipment is kept in the central warehouse adjacent to the shop, for the Winter, where it is thoroughly overhauled. Patrol work usually starts about April 1, and lasts continuously until December 1 of each year. During the Winter we make no attempt at keeping roads open for cars, and the patrolmen work the odd day only when something unforeseen occurs on their roads.

Duties of a Patrolman.—The patrolman's duties are as varied as a farmer's but everything is done pretty well according to season. During the month of April, or as soon as he starts out in the Spring, all roads are made passable for cars. Deep snow banks are cleared away, drains and culverts opened, and snow fences taken down and stored for the Summer. During the month of May when the frost is coming out, many frost boils occur, which have to be attended to, the patrolman's sole desire being to keep traffic moving and to see that trucks do not overload. Power maintainers are also busy at this time.

The month of June and part of July are devoted to patching bituminous surfaces and replacing winter's destruction. At the proper time in July all weeds and grass



Which *TYPE PAVING* best fits

Plans that intend to stretch paving dollars as far as they can practically go, in *miles* and in *labor,* lead logically to the selection of *asphalt.* No other material goes so far in long-wearing road miles, and in the distribution of road-building employment. The question is: Which *type* of asphalt paving best fits your plans? You'll find the answer in a clear understanding of the three principal types:—

LIQUID ASPHALT?

LIQUID ASPHALT—formerly known as "road oil" and used to lay dust—has been developed into an effective *bonding material,* manufactured to rigid specifications by the Standard Oil Company (Indiana). It is made in four grades—to fit all seasonal conditions, types of aggregate, and methods of mixing—and is now being used on approximately 8,000 miles of road each year.

Durable and easy riding roads result from the use of Standard Liquid Asphalt—either road-mixed or pre-mixed. The lowest-cost type of Asphalt road construction.

Hundreds of miles of state highways are constructed with Standard Liquid Asphalt. Minnesota highways No. 3 and No. 9 are shown above.

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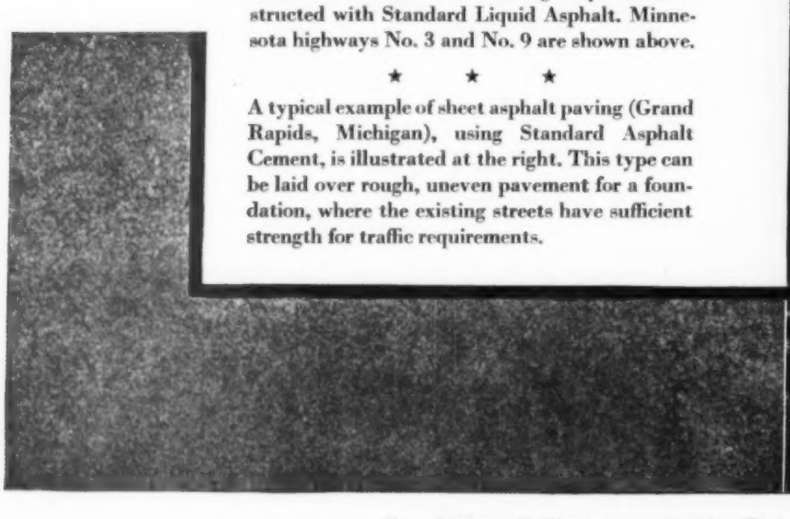
PAVING ASPHALT CEMENT?

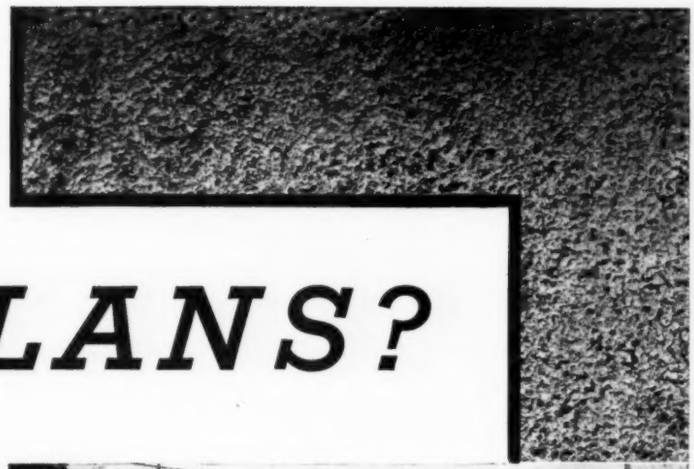
PAVING ASPHALT CEMENT—used in sheet asphalt pavement, which consists of a wearing course made from a hot mixture of



A typical example of sheet asphalt paving (Grand Rapids, Michigan), using Standard Asphalt Cement, is illustrated at the right. This type can be laid over rough, uneven pavement for a foundation, where the existing streets have sufficient strength for traffic requirements.

Yes—We would like you to mention ROADS AND STREETS

ASPHALT YOUR PLANS?



paving asphalt cement, mineral dust and sand; and a binder course consisting of a hot mixture of asphalt cement, sand and mineral aggregate. This is one of the oldest types of asphalt pavement and its advantages are (1) that the surface is easily repaired for service cuts, (2) that it may be used over rough, uneven existing streets that have sufficient foundation-strength for traffic requirements.

★ ★ ★

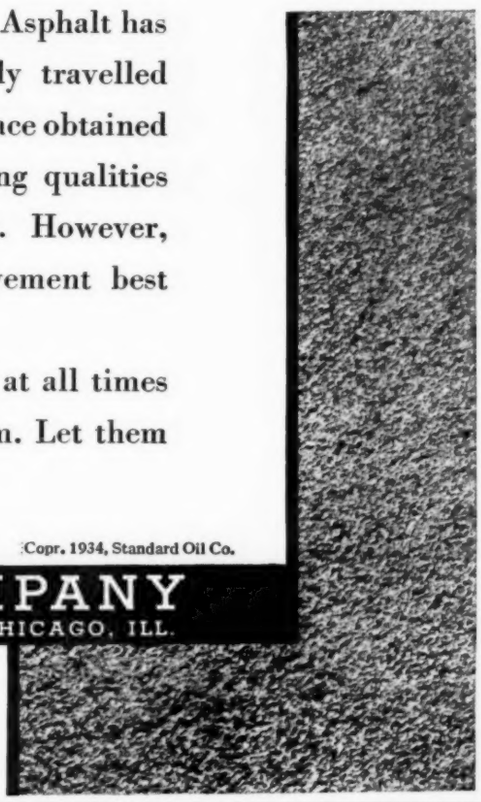
CUT BACK ASPHALT—as made by the Standard Oil Company (Indiana) is a pure, high-grade paving asphalt cement, cut with a special diluent of correct boiling point to give the *delayed* initial set necessary to permit proper mixing on the roadway and *complete final* set which allows the paving asphalt to return to its original strength.

CUT BACK ASPHALT ?

Cut Back Asphalt, when made with high grade asphalt cement and correct diluent, presents a remarkable, long-wearing, non-skid surface to traffic. The view above shows an Indiana highway. More miles of Stanolind Cut Back Asphalt pavement have been laid in the Middle West than any other kind since the introduction of this type by the Standard Oil Company (Indiana).

For five years a half-inch surface of Stanolind Cut Back Asphalt has been handling the traffic on the world's most heavily travelled street—Michigan Boulevard, Chicago. The non-skid surface obtained with Cut Back Asphalt, as well as its splendid wearing qualities and comparatively low cost, particularly recommend it. However, *your own plans* must dictate the type of asphalt pavement best fitted to your program.

Standard Oil Company engineers are ready and glad at all times to contribute worth-while advice on any paving problem. Let them consult you on yours.



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STANDARD OIL COMPANY
910 S. MICHIGAN AVE. (*Indiana*) CHICAGO, ILL.

Tax payers demand lower road costs, but adequate mileage. The current situation demands the maximum spread of employment on any local project undertaken. If it's road building—ASPHALT is the logical answer.

along highways are cut. During the balance of July, August and part of September, the roads requiring it, are given a bituminous surface treatment. The material is sprayed by contract, where required by the patrolman, and the patrol gangs work in groups to get out cover material. We have always preferred light treatments often, preferably each year, rather than heavy treatments every second year. We use sand and fine gravel almost exclusively for cover.

During the balance of September and October more patching is done, and material added to traffic-bound roads. Award ditches are cleaned out at this season, together with other miscellaneous jobs, such as culvert repairs, etc.

Road signs are painted up to be more serviceable during the long dark Autumn evenings. In November the snow fences are erected, and all obstacles that might cause snow to drift are removed. Then comes the long cold Winter when all equipment is brought in to the well-heated modern shop to be over-hauled by the mechanic. Shop work is supervised by the general foreman who orders parts and stock, and makes a detailed report to my office. When a truck or tractor is being overhauled, it is our intention to have the operator assist the mechanic, so that he may learn something about the inner working of his machine.

The organization which I have just described is the result of 17 years of development. We feel that the number of patrol divisions should be increased and the mileage of each decreased, but this will come in time. It was a hard problem to change over from 60 or more local patrolmen to the motor system which we have been operating under exclusively for the past six years. During the past three years we have not changed a man, and have had not a complaint during the past two years, with regard to the work the men are doing. We have always tried to select men who did not pretend to know anything about road work but showed enthusiasm, and we trained them for the work. We consider our patrol organization as a sort of a technical school, with the general foreman and myself as instructors, and the patrolmen as students, all working together trying to solve each problem in the most efficient manner. Our shop is the class room and our roads are the laboratory, where the boys are always discovering new and useful knowledge for the instructors.

Acknowledgment.—The foregoing is an abstract of a paper presented at 20th annual conference of County and Township Engineers and Road Superintendents of Ontario.

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Driving Piles into Blasted Bedrock

In the construction of a bridge over the Brodribb River in Victoria, Australia, the substructure was supported on piles driven into the bedrock. How this was done is described in the 20th annual report of the Country Roads Board (for year ended June 30, 1933) by L. F. Loder, Chief Engineer of the Board.

The bridge is 200 feet long and 22 feet wide, consisting of three spans of 64 feet, 72 feet, and 64 feet, and has a cantilever arrangement of plate girders with a suspended span of 50 feet. The deck is of timber on 6-in. x 7-in. timber crossbeams.

Borings indicated that the rock continued across the river from the high hill on the west bank, but at too great a depth to be used on the east bank. Over the stream width, rock is overlaid by 5 to 10 feet of silty mud and by 12 to 16 feet of water with low velocity except at flood times. It was difficult to drive piles in the normal manner, and the depth of water made the use of concrete piers fairly costly. It was, therefore, resolved to try the method of driving the piles into the bedrock, which was previously shattered by explosives at the site of each pile. Holes were drilled into the rock through a 1½-in. diameter pipe, which was driven to rock first and securely fastened to the staging. The soles were then loaded with a continuous string of gelignite over the drilled depth. This has the effect of leaving a clean vertical hole into which the pile point may be driven. The diameter of the hole and cross section of the charge will vary with the particular rock, but it would appear that a single row of plugs is about right for materials of the hard sandstone type. The penetration of the pile into the rock was 3 to 4 feet. This method was used about 40 years ago for the piers of the Sunday Creek bridge on the Hume Highway, and was so effective in that instance that the old piles were subsequently removed only by being cut through. The base of the piles was comparable in fixity to a pile potted in concrete into solid rock. The same fixity was noted at the Brodribb River piers, where the double row of piles in each pier required considerable force to bring them together at the tops. The bridge is of deck type on three lines of plate girders, with a skew of 30 degrees. The plate girders were shop-welded for the most part, but splices and erection of transverse stiffening frames were done in the field using a direct current welding set.

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For Roads and Schools Both

In spite of the generous gesture of Mayor Kelly who offers to surrender Chicago's 1-cent share of the Illinois gasoline tax for use in school relief, that proposal, as originally advanced in more generally applicable terms by Gov. Horner, should be regarded with suspicion by advocates of the school cause. Downstate cities and counties are strongly opposed to any diversion of the gas tax, and an army of Chicago automobilists, bumping over city highways sadly in need of repair, will not regard with favor the mayor's needless liberality with the money that would contribute to their security and comfort.

Throughout the state the gas tax already has been figured into budgets for the ensuing year. To require its diversion now would be to work a hardship, to demand a sacrifice that should be asked only in case of an emergency for which no other way of relief was open. And other and better ways are open. The bill to appropriate state liquor revenue for school use has passed the house and is on second reading in the senate. A bill to appropriate for the schools all sales-tax revenue exceeding $2,500,000 a month has enlisted considerable support. Proposals to issue bonds with which to pay the $12,500,000 three-year deficit in the state distributive fund have been introduced. Those measures have merit, and are wholly free from the objections that apply to proposals to divert funds already included in municipal budgets and appropriated for needful and proper purposes, and apply also to proposals for new taxation.

Peril to the schools lies in the fact that the administration is offering its gas-tax juggle as a substitute for liquor revenue and sales-tax surplus proposals. The governor has no assurance that the legislature will accept the substitute, and, in a bemuddled situation that has become politically supercharged, all relief proposals may fail. In that disastrous event responsibility would be squarely on the governor and the Kelly-Nash machine.—Editorial in Chicago Daily News.

How Shall We Use County Road Funds?

By C. Dana Ward

President, Highway Materials and Equipment Association

THE growing demand for year-round transportation has increased the investment in local roads in Indiana to the enormous sum of $550,000,000 to $600,000,000. This is exclusive of the investment in state highways. The problem confronting the county and city officials today is the preservation of this investment on the small amount of money given them for maintenance and needed construction. The Auditor of State distributed last year to the counties and cities approximately $7,500,000 to be used for the express purpose of maintaining and constructing roads, streets, and bridges.

In some localities of the state, however, the officials found it expedient to use this money for purposes other than those provided by law. Some used their funds for retirement of bonds issued against roads that are purely local; others even used the money for general operating expenses. This brings the gasoline taxpayers into the spotlight as the real forgotten man. The average motorists in this way pays more than his share of governmental expense. The fellow who uses his car for commercial purposes with a probable net income of $1,200 a year, driving 20,000 miles a year, pays four times as much for governmental expenses as the wealthy man whose chauffeur drives him to the office and picks him up in the evening, with a total car mileage of probably 5,000 miles a year.

The official charged with the wise usage of the road funds is actually on trial. The legislature meets again next January. It is not unreasonable to presume that the law makers will look into the stewardship of this money—whether it was used for the purpose for which it was collected. If it has not been used for that purpose, it is reasonable to presume also that someone in the legislature will get the bright idea of reducing or redistributing this revenue.

The last legislature gave full consideration to a measure which would have permitted the use of the road funds for the retirement of local bonds, but in the wisdom of the 130 men who comprise the legislature, the measure was defeated. These men realized that our local highway systems required protection just the same as any other property, which is an adequate maintenance fund. I'm sure we all know the legislature is not overgenerous in matters of this kind and this instance is no exception. They gave you barely enough money to do your job properly.

Each one of you officials is operating a big business, which is your local unit of government. I'm sure that you, as business men, will realize as all business men will, that $7,500,000 a year is not excessive to operate a plant investment of $550,000,000, especially when this plant is subjected to the hard usage that our highways get throughout 12 months in the year.

Four or five years of neglect of these secondary roads will mean their complete deterioration, and they would have to be replaced at a cost far greater than $550,000,000. But over this same period $30,000,000 to $35,000,000 can be properly and scientifically used to preserve the highways to the satisfaction of the fellow who pays the bill, and he is Mr. Gas Taxpayer And, it will take every red cent you get from this source to do your job well.

There is no other alternative—either a maintenance cost of $30,000,000 for five years, or replacement at more than $600,000,000. The responsibility lies in your hands.

Acknowledgment.—The foregoing is a paper presented at the 20th Annual Purdue Road School, in response to an address of welcome by Prof. W. E. Hatt.

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U. S. Will Conduct Finance Study of Minnesota Roads

Arrangements have been completed by the state highway department of Minnesota for a Federal financial survey of state, county, township and municipal roads throughout the state.

The study will be carried out by the U. S. Bureau of Public Roads. It will be directed by Professor Henry R. Trumbower, professor of economics at the University of Wisconsin and economist for the Bureau of Roads. H. R. Briggs, statistician for the Bureau of Roads will be in direct charge of the work which will start at once.

Primary aims of the survey are:

1. To analyze all highway expenditures and revenues of the state, of the counties and of townships and municipalities.

2. To show the total revenues raised for other governmental purposes by the state, the counties and other governmental units in comparison with revenues raised for highways, bridges and streets.

3. To show the effect of highway and related taxes on property of all kinds.

The survey will also show the cost per mile of maintaining and improving the various classes of roads under jurisdiction of different governmental units. Comparisons will be made with other states, for the U. S. Bureau of Roads has made similar studies in Wisconsin, Michigan and elsewhere.

The Highway department and the Bureau of Roads also expect to conduct a traffic census which will show the origin and destination of traffic on the highways, as well as the volume of traffic.

"Facts developed by these studies," Mr. Elsberg said, "should be of great value to the state in solving problems of highway development and highway taxation. The results of the survey will be made available to the Citizens Interim Highway Committee recently named by Governor Olson."

This committee is to make a study of Minnesota highway problems and report to the next legislature.

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A New Course in Blueprint Reading.—Training in reading blueprints intelligently is offered in a new short course for correspondence study, announced by the Extension division of the University of Wisconsin at Madison, Wis. In three parts, the course offers help in understanding general blueprint reading and either civil and structural or mechanical engineering blueprints. No time is spent in explaining how the drawings should be made, except where the method of drawing is essential to an understanding of the print. This course, which is given for men in Wisconsin and other states, was prepared by the Extension department of civil and structural engineering, Prof. H. E. Pulver in charge. A standard text is used.

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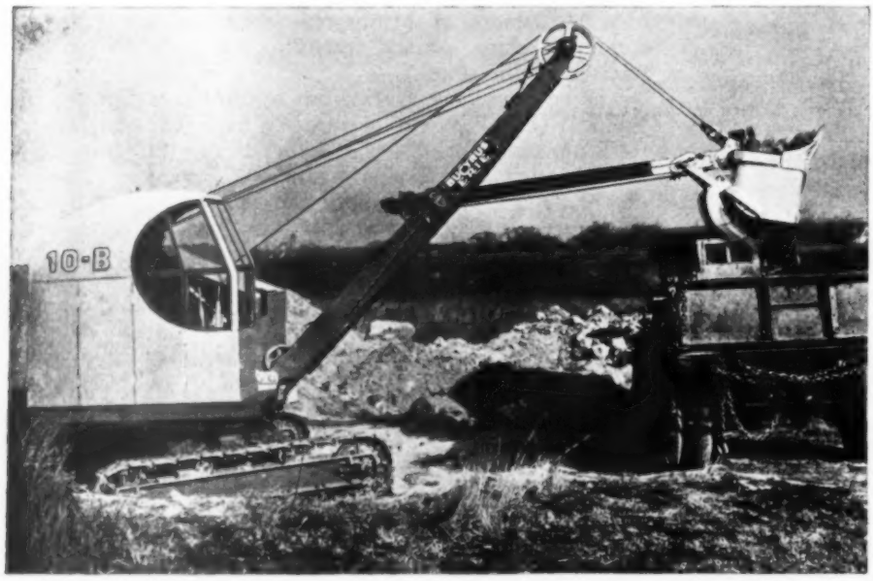
Large Concrete Bridge to Be Erected in Germany —A reinforced concrete bridge 869 ft. long and 75 ft. wide to be erected in Germany in connection with the construction of the new automobile road from Munich to Salzburg.

New Equipment and Materials

New ⅜-Yd. Full Revolving, Convertible Excavator

The new 10-B, ⅜-yd. excavator, just announced by Bucyrus-Erie Co. of South Milwaukee, Wis., is fully and quickly convertible. It is offered with all types of front end equipment as a shovel, dragline, crane, clamshell, drag shovel, skimmer scoop, back filler or piledriver.



New 10-B ⅜-Yd. Excavator of Bucyrus-Erie.

Full revolving, the 10-B is stated to offer practical working ranges that compare favorably with larger machines. The shovel with standard boom at 45° has a maximum cutting radius of 20 ft. 3 in., a clear dumping height of 12 ft. 6 in. The crane rating at 10 ft. radius is quoted at 7,000 lb. Dragline and clamshell easily handle a ⅜-yd. bucket on a 28-ft. boom.

The machine weighs only 7½ to 8 tons depending on the equipment used—an important feature for those who must move their machines over highways. This light weight and the compactness of the machine has been secured by utilizing high quality, heat-treated, modern alloy steels with welded construction and simplified design, so that all the strength and dependability of a much heavier machine is secured.

With the 10-B speeds to 4¼ miles per hour are available. It steers accurately through friction clutches as readily as a tractor, making long, short or right-angle turns. It easily climbs grades even steeper than 30 per cent.

This new, fully-revolving, ⅜-yd. machine is remarkably compact, having a tail swing of only 5 ft. 7 in. This makes it particularly suited for work in close quarters frequently encountered with a machine of this size. Among the many mechanical features that make the performance of the 10-B possible are automatic lubrication; ball and roller bearings throughout; elimination of center pintle by the hooked-roller swing-circle which has proved so successful on Bucyrus-Erie's 16-B and large railway cranes; new type of boom construction; a revolutionary new dipper, and power dipper trip.

For full detailed description of the 10-B, write Bucyrus-Erie Co., at South Milwaukee, Wis., mentioning this publication.

New Curing Medium for Concrete

A new curing medium that is claimed to adequately protect concrete against evaporation during the period of hydration has been produced by the research laboratory of The Johnson-March Corporation, 52 Vanderbilt Ave., New York City. The material is transparent, does not combine with the concrete surface nor stain or change its appearance in any way. It is further stated that the material has sufficient elasticity to bridge any cracks or fractures due to displacement or settlement.

This curing medium is known as Ritecure. It is supplied in the form of a milky white liquid. When sprayed on the "green" concrete it has the appearance of white paint. The color starts to dissipate within ten or fifteen minutes (depending on the temperature and humidity) and disappears entirely within a few hours, leaving the surface of the concrete covered with a transparent, flexible membrane or film that is impervious to water and not affected by the action of the elements. Ritecure is applied by means of a simple pressure spray outfit, at the rate of approximately 40 sq. yd. per gallon of material.

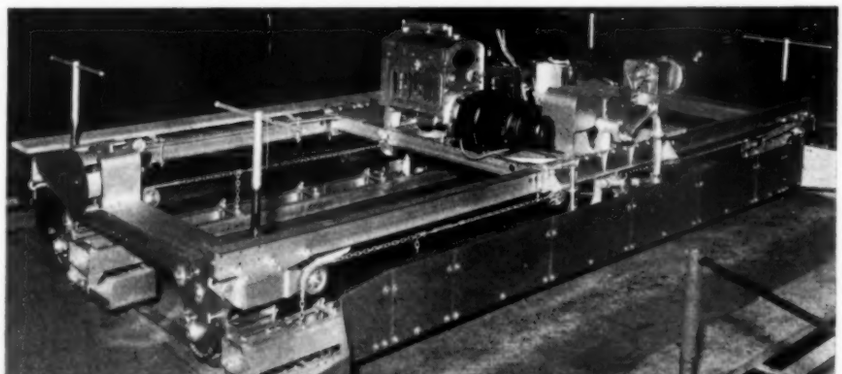
New Blaw-Knox Gas-Electric Road Finisher

The Blaw-Knox Co., 2003 Farmers Bank Bldg., Pittsburgh, Pa., has developed for the 1934 construction season a road finisher for concrete and bituminous paving which is fully electrically powered, power being furnished by a generator direct connected to a gas engine mounted on the machine. It has finger touch control without exertion of any particular effort on the part of the operator. Before placing this machine on the market it was conclusively tested and proved on four paving projects totaling 20 miles. The new Blaw-Knox gas-electric finisher has four speeds forward and reverse instead of two. Traction is now equal on all four wheels, and maximum grades under a full load can be covered with ease.

Briefly summed up, the chief characteristics claimed for this new machine are as follows:

It has faster forward and reverse motion.

Less time is necessary to change ma-



New Blaw-Knox Gas-Electric Road Finisher.

chine widths, the new machine being adjustable by inches.

It is faster in crown adjustment, and is equipped with redesigned and simplified screeds which are electrically operated.

It has greater traction for handling heavier loads and dryer concrete.

Raising jacks for elevating and lowering the finisher above the forms are built into the machine.

It has cushioned gas-electric power to take operating shocks without undue stress or wear.

It has no clutches, few gears, and all moving parts have been greatly reduced.

It steers very easily by stopping one motor—a matter of finger-tip control.

It is equipped with automatic brakes, which hold the finisher on all grades.

It has electric connections for floodlighting for night work, with ample reserve power, which can be used for operating tools if necessary.

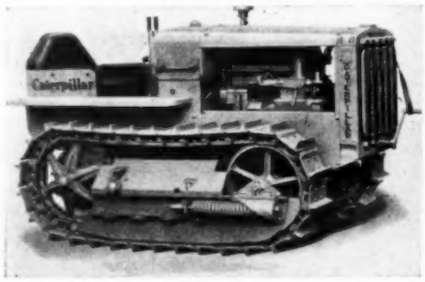
It is equipped with roller bearings and is bronze bushed throughout.

It is designed for addition of vibrating attachments, tamper, and accessories for bituminous paving.

"Caterpillar" Twenty-two Tractor Announced

The triple economy of low first cost, operation on inexpensive fuels and the power savings of track-type traction are among the many outstanding features of the new "Caterpillar" Twenty-two Tractor, according to an announcement recently issued by Caterpillar Tractor Co. of Peoria, Ill.

The new model is powered with a 4-cylinder, 4-cycle, valve-in-head engine developed especially for converting a wide range



"Caterpillar" Twenty-two Tractor.

of low volatility fuels into efficient, dependable tractor performance. The engine has a 4-in. bore and 5-in. stroke and develops a maximum horsepower of 23.69 at the drawbar and 28.39 on the belt at governed speed of 1,250 r.p.m. Lubrication is force feed to all main, connecting rod and rocker arm bearings. A twin fuel tank holds 20 gal. of tractor fuel and 2 gal. of gasoline, which is used in starting, and a 3-way fuel control valve is located on the dash in easy reach of the operator.

The fuel and cooling systems, manifolds and cylinder head have all been designed to give uniform, high operating efficiency in handling low cost fuels. The carburetor is located directly beneath the heated manifold jacket and a heat exchange valve is provided to insure thorough vaporization of the fuel before it enters the cylinder. Water circulation is controlled with a thermostat and a radiator by-pass allows the engine to warm up rapidly. The new Eisemann magneto, with which the tractor is equipped, is of the stationary winding inductor type, which requires no lubrication and is also said to be simpler and more accessible than magnetos formerly used in tractor service.

The Twenty-two is available in either standard or wide gauge models. The standard machine has a shipping weight of 6,150 lb.

A New Surface Heater for Street Repairing

Over the past few years resurfacing and patching of streets by the surface heater method has greatly increased. Large and small cities and towns have followed the lead of Washington, D. C., New York City, Cincinnati and Philadelphia in the use of surface heating equipment.

Four Littleford Low-Pressure Surface Heaters Working in Front of the White House, Washington, D. C.

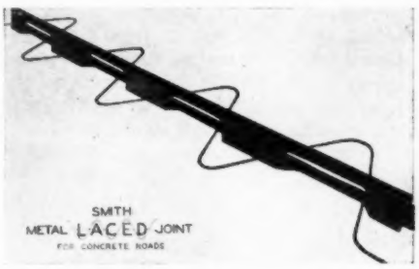
In keeping with this trend, Littleford Bros., 454 E. Pearl St., Cincinnati, O., have added a new surface heater to their line of road maintenance equipment; it is known as the No. 98-LP Low-Pressure Surface Heater.

This outfit differs from the standard Littleford surface heater in that it is heated by low-pressure burners instead of coil-type burners. The low-pressure burner requires no preheating—it lights instantly; it consumes domestic fuel oil and efficiently produces a great amount of heat.

New Joint for Concrete Roads

"Metal-Laced Joint" is the name of a new closed joint for concrete roads, just announced by the A. O. Smith Corporation, Milwaukee, Wis.

Accompanying illustration reveals the principle of design, involving a vertical plate through which is threaded a zig-zag steel rod. No stakes or supports are required. The plate is shaped so as to provide a slab interlock or transfer of load vertically, while the zig-zag rod serves to "lace" the slabs together. The joint is matematically proportioned to use every pound of metal in the most efficient manner. Incidentally, this joint furnishes a



New Joint for Concrete Roads.

desirable steel reinforcement of the slabs for 10 in. along adjoining sides.

"Metal-Laced Joint" has few and simple parts, which are easily and quickly assembled and handled. It is produced in standard 10-ft. units, and designs are available for both longitudinal and transverse joints. A variety of rod diameters, plate widths and gauges are offered, thus providing various combinations to meet all of the different highway requirements.

Hercules Hydraulic Steer and Scarifier

The Hercules Model 100, 10-ton three-wheel road roller of The Hercules Co., Marion, O., is now available with hydraulic power steering control, especially developed and adapted to roller use. A cast steel steering arm is mounted directly on the squared top of the king post, connected to which is the hydraulic piston and cylinder. The latter is firmly anchored to the roller frame and mounted on a cast steel saddle. The steering control is located in the operator's cab, and the roller changes the direction of its course smoothly and easily with a slight touch on the steering control.

Also announced is the Hercules hydraulic scarifier, a powerful roller scarifier so designed that the scarifier teeth may be stopped at any desired point in the vertical movement of the tooth bar.

Another recent development by The Hercules Co. is the cast steel center rear roll. A cast steel spider forms the spokes in this two-piece wheel, while separate

semi-steel rims of any desired width may be mounted thereon. This feature enables the roller user to widen the scope of work done by his roller, as where he has occasion to use rolls of greater width than standard, or of special section as in the case of earth fills and in the construction of earth dams, he may obtain these wider rims, or rims of special section, at the same time he purchases his roller with standard equipment, and simply by changing from one type of rim to the other in the field the roller is made available for the work on which it is desired to use it.

Windrow Eliminator

The Hi-Way windrow eliminator is an attachment for any motor patrol grader for eliminating the windrow deposited by the grader blade in the middle of the road. The operation of the windrow eliminator is simple, requiring very little attention during the day's run. Hydraulic lifts are provided for raising and lowering the blade. This blade is not a grading blade,

Hi-Way Windrow Eliminator.

and is only to be used for smooth spreading of the surplus material back across the graded surface and depositing stones and clods at the roadside. The blade is reversible so that the windrow may be taken from either side.

The windrow eliminator is available for attachments to all makes of motor patrol graders and is sold and serviced through road machinery dealers. The eliminator is a product of the Hi-Way Service Corporation, 3841 W. Wisconsin Ave., Milwaukee, Wis.

A New Wagon Drill

The Cleveland Rock Drill Co., Cleveland, O., has announced its model "WD" wagon drill. One of the pictures shows the machine as set up for down hole drilling, and the other for flat holes. It is stated it will drill at any angle between these extremes, above or below the horizontal.

When feeding into the rock, the mechanism is claimed to automatically maintain the drilling machine at just the right position for fastest cutting. It is further claimed that when reversing or when approaching the rock, the speed of feeding may be varied from a few inches to 25 ft. or more per second. Very little air is required for the feeding mechanism, not over 4 cu. ft. per minute for ordinary rates of feed.

The air feed cylinder serves as a boom or support for the guideways on which the slabback mounted machine travels when being fed into or reversed away from the rock. The boom is mounted on an offset "U-bar" which can be fixed in any position around the center line of the wheel

The Model WD Wagon Drill in Action.

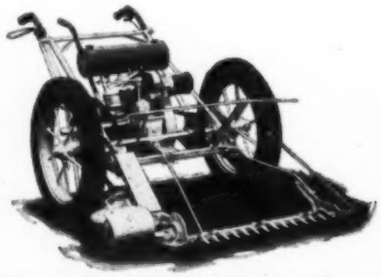
axle. This arrangement permits of placing the machine in an infinite variety of positions, heights and angles.

The drilling machine which has been designed for use with this wagon drill is provided with a special blower. A slight pull on the blowing valve lever suddenly turns full pressure through a ¾-in. hole into the chuck chamber at the end of the shank, automatically short stroking the hammer and blowing any hole. This hole blowing feature can be incorporated in a wet drill as well as in the dry construction.

New Power Mower

A new hand operated rubber tired sickle bar power mower is being produced by the Toro Manufacturing Co. of Minneapolis, Minn.

This new mower, which is called the Parkway, cuts a swath 30 in. in width and



New Rubber Tired Sickle Bar Mower

is powered with a two-hp. Toro 4-cycle motor. It is equipped with 26-in. pneumatic tired wheels, which enable it to climb steep grades and work on the roughest kind of ground.

Colprovia Roads, Inc., Moves Executive Offices

Colprovia Roads, Inc., announces that its executive offices have been moved from 247 Park Ave., New York, N. Y., to 183 E. Main St., Rochester, N. Y. The laboratory will be continued at the Grand Central Palace Building, 480 Lexington Ave., New York, N. Y. Charles W. Denniston, recently elected president of the company, and Edmund Johnstone, who is continuing as vice-president and chief engineer, will both be located at the executive office in Rochester. Mr. Johnstone will continue to be in charge of technical matters, and under the new arrangement will be able to devote an increased part of his time to assisting licensees with their plant and manufacturing problems.

Dave Kennedy Takes Over Midwestern Sales for Adnun Engineering

The Adnun Engineering & Manufacturing Co. of Nunda, N. Y., announces that Dave Kennedy has been appointed Midwest sales manager for both this company and The Foote Co. of Nunda. It will be remembered that Mr. Kennedy has long been connected with the Northwest Engineering Co., both in the capacity of treasurer and assistant sales manager. Previous to this experience Mr. Kennedy had served with the International Harvester Co., with the Federal Trade Commission during the war and as works manager of the Moline Tractor Co.

Thompson & Son Now Distributors for Hunt and Ritecure Processes

The Johnson-March Corporation, 52 Vanderbilt Ave., New York, N. Y., manufacturers of the Hunt and Ritecure processes for curing concrete, announces the appointment of James J. Thompson & Son, 204 West St., New York City, as their exclusive distributors for New York state and other parts of the East. John J. Gastieger, well known to highway officials and contractors, is sales manager of the Thompson company.

Hercules Motors Establishes Direct Representation on Pacific Coast

Hercules Motors Corporation, Canton, O., is re-establishing direct factory representation on the Pacific coast. Oliver S. Kelly of the company's organization will have headquarters in San Francisco and will take care of its many interests on the Pacific Coast section.